Unibrain Fire-i industrial firewire cameras

Models: 501/511/601/701/702/810

User Operation Manual

Version 3.0 July 2008

unibrain
The 1394 Innovators

Legal Notice

For Customers in U.S.A.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

For customers in Europe

This apparatus has been certified to meet or exceed the standards for CE compliance per the Council Directives. Pertinent testing documentation is available for verification.

For customers in Canada

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes Classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life support applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Allied customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify allied for any damages resulting from such improper use or sale.

Before You Start

This manual should help you in installation and setting of the camera and we recommend you to carefully follow the instruction described.

To ensure that your warranty remains valid, read the manual carefully before using the camera.

DO NOT disassemble, modify or repair the camera since there is no user serviceable part inside and may void warranty. For prevention of fire or electric shock DO NOT remove screws or cover from the camera.

Operation in wet are is NOT recommended and camera SHOULD NOT be exposed to rain or moisture. For prolong life and use of camera's CCD, do not point the camera directly to the sun or strong spotlight which may result CCD blooming and permanent damage. DO NOT operate camera beyond operation temperature range stated and AVOID usage in conditions exceeding 90% humidity.

DO NOT use unregulated power supply source to prevent camera's circuit damage.

Use soft materials such as lens tissue or cotton tipped applicator with ethanol for CCD faceplate cleaning ONLY when necessary and AVOID contact with fingers or any hard object. Do not use solvent, abrasives or detergent in case of cleaning camera body.

Warranty shall be voided for improper usage or fault caused by user or damage caused by other equipments due to negligence

Warranty

Unibrain warrants the original components free of defects for one year from purchase date. This warranty covers failures and damage due to defect which may occur during normal use. It does not cover damages or failure resulting from mishandling, abuse, misuse or modification. For every repair or replacement, RMA numbers must be obtained in advance.

Disclaimer

The information in this document has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies, nor is any responsibility assumed by Unibrain. There is no legal obligation to documenting internal relationships in any functional module of its products, which is realized in either hardware or software.

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1. Introduction

1.1. Overview

Unibrain's new **Fire-i IIDC 1394a camera series** opens up a new horizon on digital image processing by providing more features in a small and robust form factor while maintaining the cost effectiveness and high quality. All models are lined up by a wide range of resolution equipped with Firewire interface and trigger to suit the need for every application.

Large selection of cameras is available and scheduled to be added to the **Fire-i camera series** which consist of various sensor sizes (1/2", 2/3" 1/3", 1/1.8") and resolution (VGA, SVGA, XGA, SXGA, UXGA) both in color and black and white. The Unibrain 1394a digital camera series consist of the following models.

Type	Model Name	CCD	Resolution	FPS at Max Resolution
Black & White	Fire-i 810b	1/1.8"	1600 x 1200	16
	Fire-i 701b	1/2"	1388 x 1040	20
	Fire-i 702b	2/3		
	Fire-i 610b	1/3"	1024 x 768	36
	Fire-i 511b	1/2"	640 x 480	86
	Fire-i 501b	1/3"		
Color	Fire-i 810c	1/1.8"	1600 x 1200	16
	Fire-i 701c	1/2"	1388 x 1036	20
	Fire-i 702c	2/3"		
	Fire-i 601c	1/3"	1024 x 768	36
	Fire-i 511c	1/2"	640 x 480	86
	Fire-i 501c	1/3"		

New Features (September 2007 production models and later)

Recent models have been enriched with new features such: Lookup table (LUT), additional external trigger modes (0 ~ 5, 12, 13, 14, 15 – depending on the model), extended shutter speed (1 us ~ 3600 sec), RS232c pass through via firewire, Horizontal and Vertical binning modes (1x2, 2x2 for monochrome SXGA and UXGA models), optocoupler hardware trigger (SXGA, UXGA models) etc.

Software support

All cameras are fully supported from Unibrain's Fire-i™ drivers and software and embed a Fire-i API™ SDK license.

Latest versions of Fire-i™ software and SDK can be downloaded from our web site: http://www.unibrain.com/downloads/

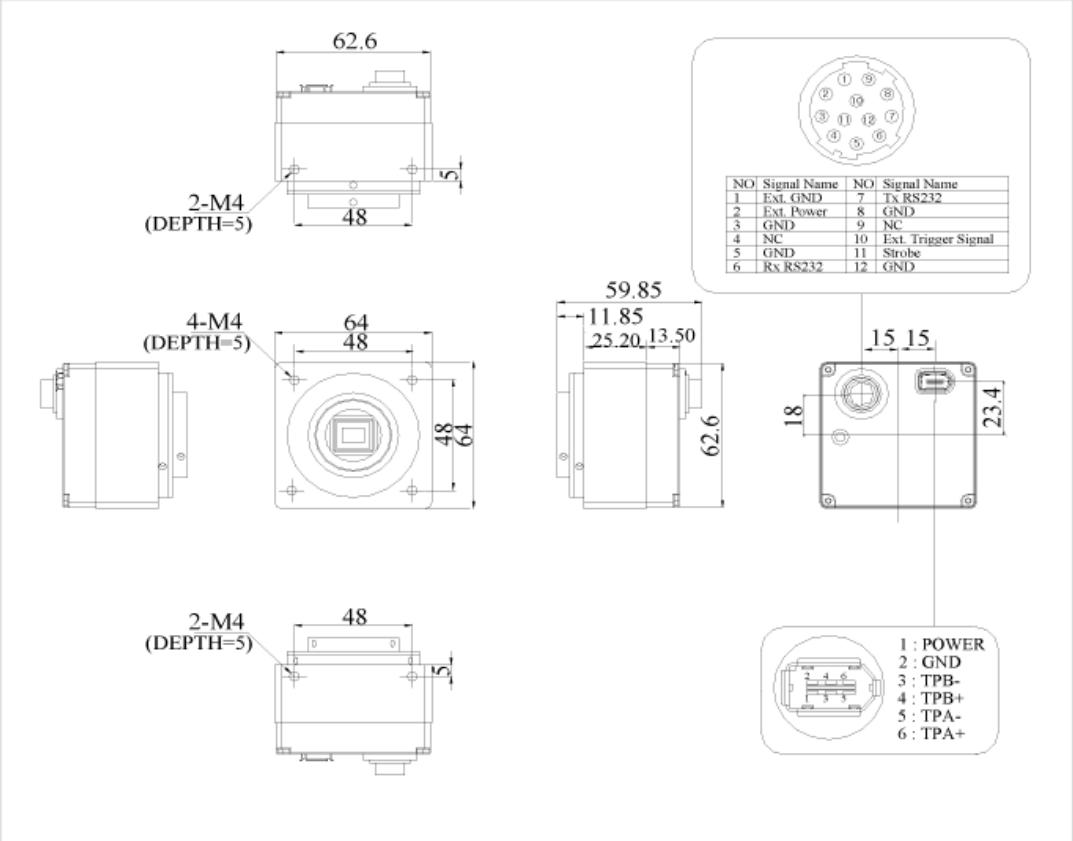
1.2. Dimensions and Description

Camera Body Size : 64 (w) x 64 (H) x 60 (D) mm

Camera Body Weight: approx. 300 gram

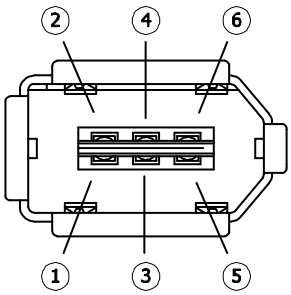
Operation Temperature: -5°C ~ 45°C / Storage Temperature: -20°C ~ 65°C

Avoid operation in environment of high humidity over 90% and allow sufficient airflow.



1.2.1. FireWire Port

The industry standard Firewire (IEEE-1394) port has the following pin assign. Data and control on the camera is operated via Firewire and camera power can also be supplied by Firewire bus.



Pin	Signal
1	VP
2	VG(Ground)
3	TPB-
4	TPB+
5	TPA
6	TPA-

CAUTION: DO NOT reverse the polarity as it will result in damaging the camera.

1.2.2. Trigger Connector Port

The External Trigger Connector provides the access to multiple I/O and also provides power as a secondary source.

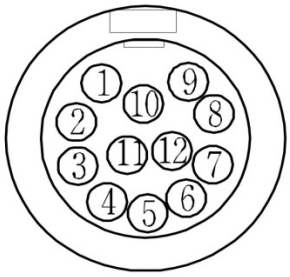
The trigger pin layout differs depending on the model:

A) Fire-i 501/511/601:

Pin	Signal	Pin	Signal
1	Power GND	7	Tx RS232
2	Ext. Power (+12V)	8	GND
3	GND	9	NC
4	NC	10	Ext. Trigger
5	GND	11	Strobe
6	Rx RS232	12	GND

Note: NC pins must have no connection

B) Fire-i 701/702/810 (models with optocoupler – September 2007 production or newer)



Pin	Signal	Pin	Signal
1	Power GND	7	GND
2	Ext. Power(+12v)	8	Rx RS232
3	GND	9	Tx RS232
4	Ext. Trigger	10	NC
5	Ext. Trigger GND	11	Strobe
6	NC	12	Strobe Power

Note: NC pins must have no connection. Changes in pin assignment from older models are indicated with blue color.

1.2.3. Status LED

LED Status	Isochronous Channel	Packet Transfer
RED	Disable	NO
GREEN	Enable	Flicker
OFF	Enable	NO

Note: When power off, LED is OFF

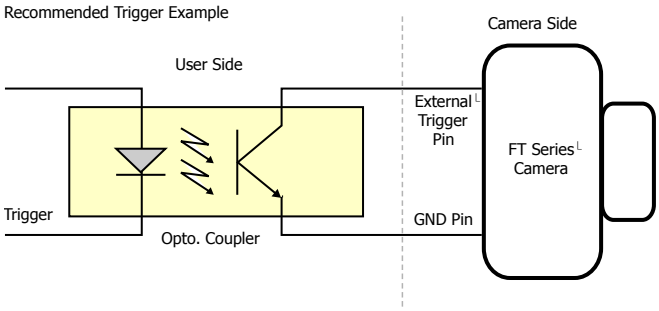
1.2.4. Camera Power Requirement

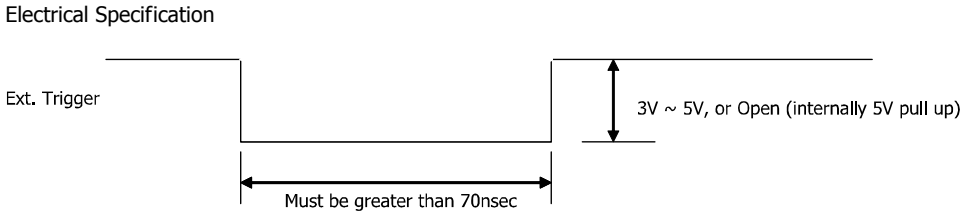
The cameras utilize a selection of power among the firewire bus and Trigger Connector Port where power source with higher voltage provides the power to the camera. Input voltage range or 8V ~ 30V is accepted.

1.3. Electrical Operating Condition

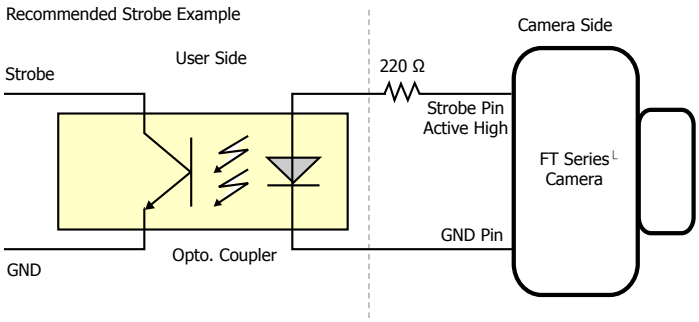
The new SXGA and UXGA models feature optocoupler (or Photo-coupler) while the VGA/XGA models still use TTL for trigger and strobe.

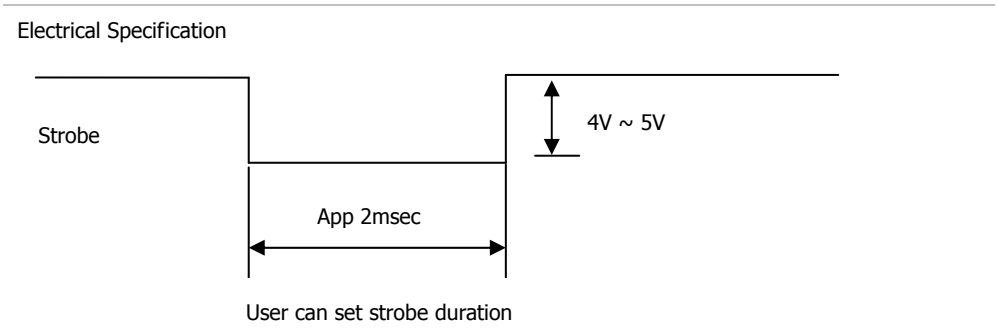
Trigger (Fire-i 501/511/601):



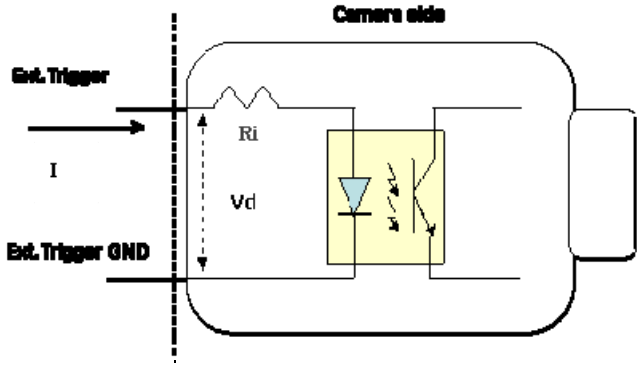


Strobe (Fire-i 501/511/601):



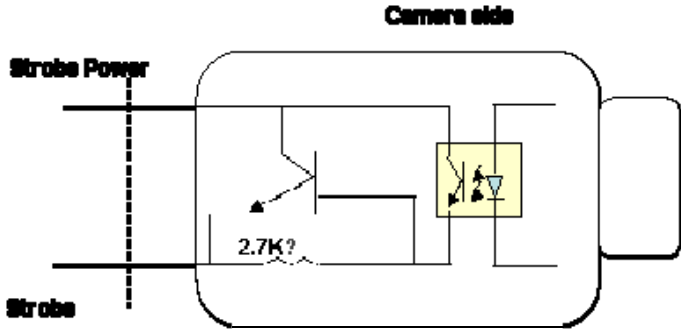


Trigger (Fire-i 701/702/810):



Parameter	Min	Typical	Max
I	7 mA	10 mA	20 mA
Ri	-	270 Ω	-
Vd	-	1.08 V	-
Rising trigger delay	2.24 us	3.34 us	3.36 us
Falling trigger delay	2.62 us	3.61 us	3.64 us

Strobe (Fire-i 701/702/810):



Strobe Power	Strobe falling delay	Strobe rising delay
5 V	26.8 us	2.16 us
12 V	7.6 us	2.8 us
24 V	3.6 us	3.4 us

1.4. Pixel Data

The Unibrain Fire-i cameras comply with the IIDC 1394-Based Digital Camera Specification v1.31 where data packets are transmitted by Firewire interface as isochronous packets. Every video format, mode and frame rate has different video data format. (Pixel data source: IIDC V1.31 Specification)

Isochronous Data Block Packet Format

0 - 7	8 - 15	16 - 23		24 - 31	
Data Length		tg	channel	tCode	Sy
Header CRC					
Video data payload					
Data CRC					

Where the following fields are defined in the IEEE 1394 standard:

data length *: number of bytes in the data field* ***tg*** *: (tag field) shall be set to zero*

channel*: isochronous channel number, as programmed in the iso_channel field of the cam_sta_ctrl register*

tCode*: (transaction code) shall be set to the isochronous data block packet tCode*

sy*: (synchronization value) shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous data blocks*

Video data payload *: shall contain the digital video information, as defined in the following sections*

Video data Payload Structure

Pn : Pixel number / packet

K : Pn x n (n = 0…..N-1)

(Pn x N = Total pixel number /frame)

<YUV (4: 2: 2) format >

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

<YUV (4: 1: 1) format >

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	V-(K+4)	Y-(K+5)

U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

<Y(Mono) Format >

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	V-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

<Y(Mono) Format >

High Byte	Low Byte

Y-(K+0)	Y-(K+1)
Y-(K+2)	Y-(K+3)
Y-(K+Pn-4)	Y-(K+Pn-3)
V-(K+Pn-2)	Y-(K+Pn-1)

Data Structure

<Y, R, G, B >

Each component has 8 bit data. The data type is “Unsigned Char”

	Signal Level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	.	.
	.	.
	1	0x01
Lowest	0	0x00

<U, V>

Each component has 8 bit data. The data type is "Straight Binary"

	Signal Level (Decimal)	Data (Hexadecimal)
Highest(+)	127	0xFF
	126	0xFE
	.	.
	.	.
	1	0x81
Lowest	0	0x80
	-1	0x7F
	.	.
	.	.
	-127	0x01
Lowest	-128	0x00

<Y (Mono16)>

Y component has 16 bit data. The data type is "Unsigned Short(big-endian)"

Y	Signal Level (Decimal)	Data (Hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	.	.
	.	.
	1	0x0001
Lowest	0	0x0000

2. Unibrain Fire-i industrial camera specifications

2.1. Black and White Cameras

2.1.1. Fire-i 810b Specification

Features		
Image Sensor /Scanning		1/1.8" Interline CCD (ICX274AL), Progressive Scan
Effective Pixels		2,010,000 pixels 1628(H) x 1236(V)
Picture Size		1600x1200, 1280x960, 1024x768, 800x600, 640x480, 320x240
Cell Size		4.40 um x 4.40 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16 16 (1600 x 1200, Format 7 mode 0) 32 (640 x 480, Format 7 mode 0) 29 (800 x 600, Format7 mode 1, 2x2 binning) 29 (1600 x 600, Format7 mode 2, 1x2 binning)
Lens Mount		C-mount
Binning		2x2, 1x2
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Optocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
SIO (RS-232)		IIDC v1.31 version : Pass through or custom command
Frame Delay from Read-out		Min. 106 us
Digital Interface / Transfer		IEEE 1394 port (6pin) / 400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage * power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp. / Storage		-5° C to 45° C / -30° C to 60° C

2.1.2. Fire-i 701b Specification

Features		
Image Sensor		1/2” Interline CCD (ICX205AL)
Effective Pixels		1,450,000 pixels 1392(H) x 1040(V)
Picture Size		1392x1040, 1280x960, 1024x768, 800x600, 640x480, 320x240
Cell Size		4.65 um x 4.65 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16 20 (1388 x 1040, Format 7 mode 0) 35 (1388 x 520, Format 7 mode 0) 37(688 x 516, Format 7 mode 1 2x2 binning) 37(1384 x 516, Format 7 mode 2 1x2 binning
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Optocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter Gain
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5° C to 45° C
Storage Temp		-30° C to 60° C

2.1.3. Fire-i 702b Specification

Features		
Image Sensor		2/3” Interline CCD (ICX285AL)
Effective Pixels		1,450,000 pixels 1392(H) x 1040(V)
Picture Size		1392x1040, 1280x960, 1024x768, 800x600, 640x480, 320x240
Cell Size		6.45um x 6.45 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16 20 (1388 x 1040, Format 7 mode 0) 35 (1388 x 520, Format 7 mode 0) 37(688 x 516, Format 7 mode 1 2x2 binning) 37(1384 x 516, Format 7 mode 2 1x2 binning
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Photocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15, 7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer Rate		IEEE 1394 port (6pin) / 400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5° C to 45° C
Storage Temp		-30° C to 60° C

2.1.4. Fire-i 601b Specification

Features		
Image Sensor Type		1/3 inch Interline CCD (ICX204AL)
Effective pixels		800,000 pixels 1034(H) x 779(V)
Picture Size		1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.65 um x 4.65 um
Real Frame Rate		30, 15, 7.5, 3.75, 1.875 / Y8, Y16 36 (1024 x 768, Format 7 mode 0) 63 (1024 x 384, Format 7 mode 0) 69 (512 x 384, Format7 mode 1, 2x2 binning) 69 (1024 x 384, Format7 mode 2, 1x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60, 30, 15, 7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Pain
SIO (RS-232)		IIDC v1.31 version : Path through custom command
Frame Delay from Read-out		Min. 70us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400Mbps
Gain		0 ~ 27 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.1.5. Fire-i 511b Specification

Features		
Image Sensor		1/2-inch Interline CCD (ICX414AL)
Effective Pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480, 320 x 240
Cell Size		9.90 um x 9.90 um
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16 86 (640 x 480, Format 7 mode 0) 154 (640 x 240, Format 7 mode 0) 157 (320 x 240, Format7 mode 1,2x2 binning) 157 (640 x 240, Format7 mode 2,1x2 binning)
Lens Mount		C-mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60, 30, 15, 7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter Gain
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 43us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 27 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage& Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.1.6. Fire-i 501b Specification

Features		
Image Sensor		1/3-inch Interline CCD (ICX424AL)
Effective Pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480, 320 x 240
Cell Size		7.40 um x 7.40 um
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16 86 (640 x 480, Format 7 mode 0) 154 (640 x 240, Format 7 mode 0) 157 (320 x 240, Format7 mode 1,2x2 binning) 157 (640 x 240, Format7 mode 2,1x2 binning)
Lens Mount		C-mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60, 30, 15, 7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 43us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 27 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.2. Color Cameras

2.2.1. Fire-i 810c Specification

Features		
Image Sensor Type /Scanning		1/1.8-inch Interline CCD (ICX274AQ), progressive scan
Effective pixels		2,010,000 pixels 1628(H) x 1236(V)
Picture Size		1600x1200, 1280x960, 1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.40 um x 4.40 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 16 (1600 x 1200, Format 7 mode 0) 32 (640 x 480, Format 7 mode 0) 29 (800 x 600, Format7 mode 1, 2x2 binning) 29 (1600 x 600, Format7 mode 2, 1x2 binning)
Lens Mount		C Mount
Binning		2x2, 1x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Photocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer rate		IEEE 1394 1 port(6pin) / 400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.2.2. Fire-i 701c Specification

Features		
Image Sensor Type		1/2-inch Interline CCD (ICX205AK)
Effective pixels		1,450,000 pixels 1392(H) x 1040(V)
Picture Size		1388x1036,1280x960,1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.65 um x 4.65 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 20 (1388 x 1036, Format 7 mode 0) 35 (1388 x 520, Format 7 mode 0 with ROI)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not Supported
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Optocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G, Auto White Balance
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 97us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.2.3. Fire-i 702c Specification

Features		
Image Sensor Type		2/3-inch Interline CCD (ICX285AQ)
Effective pixels		1,450,000 pixels 1392(H) x 1036(V)
Picture Size		1388x1036,1280x960,1024x768, 800x600, 640x480, 320x240
Cell Size(um)		6.45 um x 6.45 um
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 20 (1388 x 1036, Format 7 mode 0) 35 (1388 x 520, Format 7 mode 0 with ROI)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not Supported
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 12, 13, 14, 15
	Source	External Trigger (Optocoupler) or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G, Auto White Balance
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 97us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.2.4. Fire-i 601c Specification

Features		
Image Sensor Type		1/3-inch Interline CCD (ICX204AK)
Effective pixels		800,000 pixels 1034(H) x 779(V)
Picture Size		1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.65 um x 4.65 um
Real Frame Rate		30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 36 (1024x768, Format 7 mode 0) 63 (1024x384, Format 7 mode 0 with ROI)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not Supported
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G, Auto White Balance
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 70us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

2.2.5. Fire-i 511c Specification

Features		
Image Sensor Type		1/2-inch Interline CCD (ICX414AQ)
Effective pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480
Cell Size(um)		9.90 um x 9.90 um
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 86 (640 x 480, Format 7 mode 0) 154 (640 x 240, Format 7 mode 0 with ROI)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not Supported
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60,30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G, Auto White Balance
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 43us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

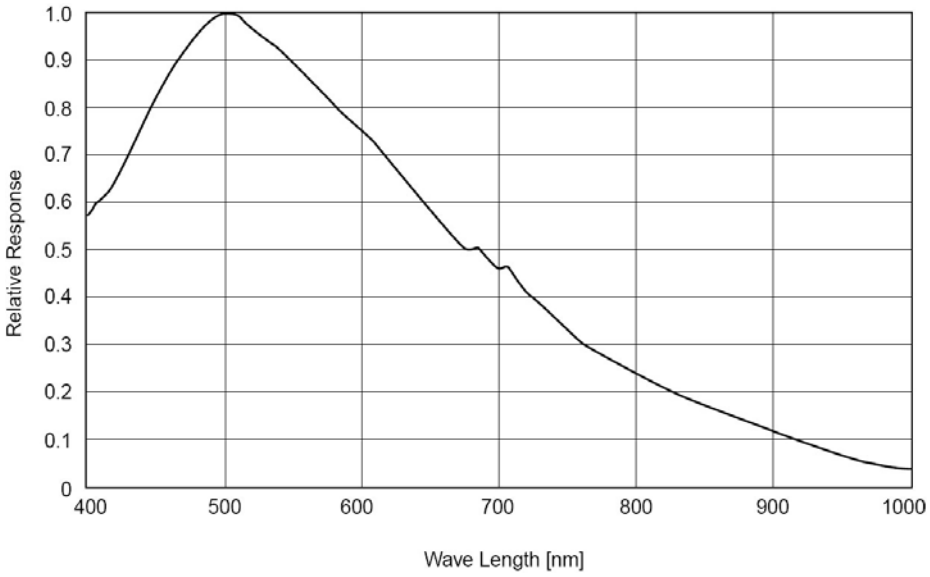
2.2.6. Fire-i 501c Specification

Features		
Image Sensor Type		1/3-inch Interline CCD (ICX424AQ)
Effective pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480, 320 x 240
Cell Size(um)		7.40 um x 7.40 um
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 86 (640 x 480, Format 7 mode 0) 154 (640 x 240, Format 7 mode 0 with ROI)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not Supported
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60,30,15,7.5 frame rate
Memory Save/Load		16 Channels (0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, Shutter, Gain
		U/B V/R, Hue/G, Auto White Balance
SIO (RS-232)		IIDC v1.31 version : Path through or custom command
Frame Delay from Read-out		Min. 43us
Digital Interface		IEEE 1394 port (6pin)
Transfer Rate		400 Mbps
Gain		0 ~ 25 dB
Shutter Speed		1 usec ~ 3600 sec (auto or manual control)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage		8 VDC ~ 30 VDC – Less than 3 Watt (@12V DC)
External Dimension / Weight		64(W) x 64(H) x 60(D) mm / Approx 300g
Operation Temp.		-5°C to 45°C

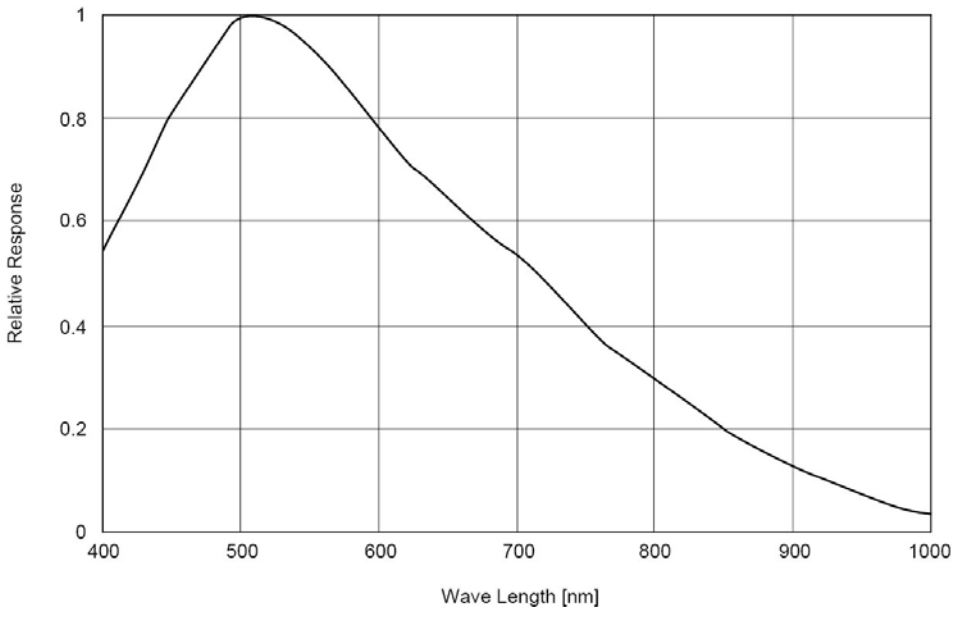
2.3. Spectral Sensitivity

Excludes lens and light source characteristic

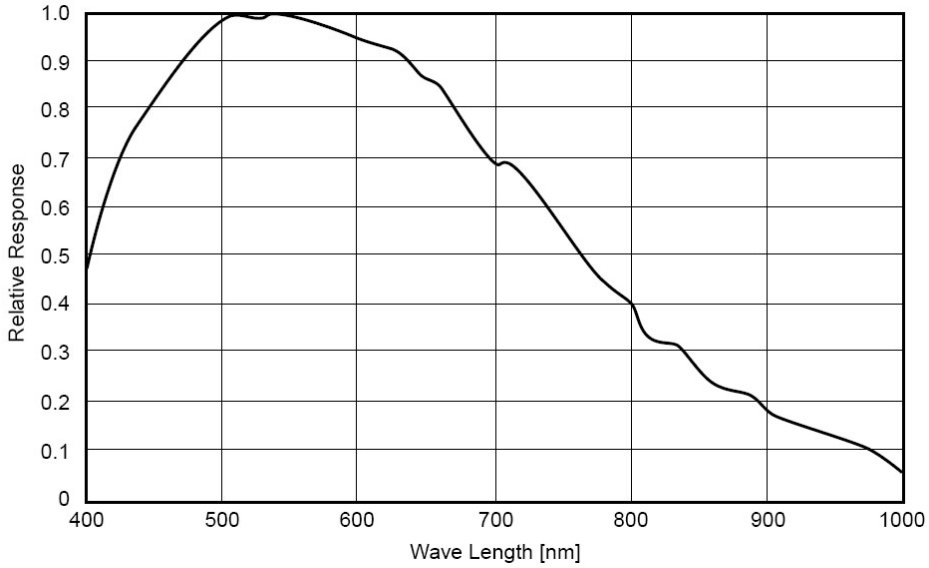
2.3.1. B&W Cameras



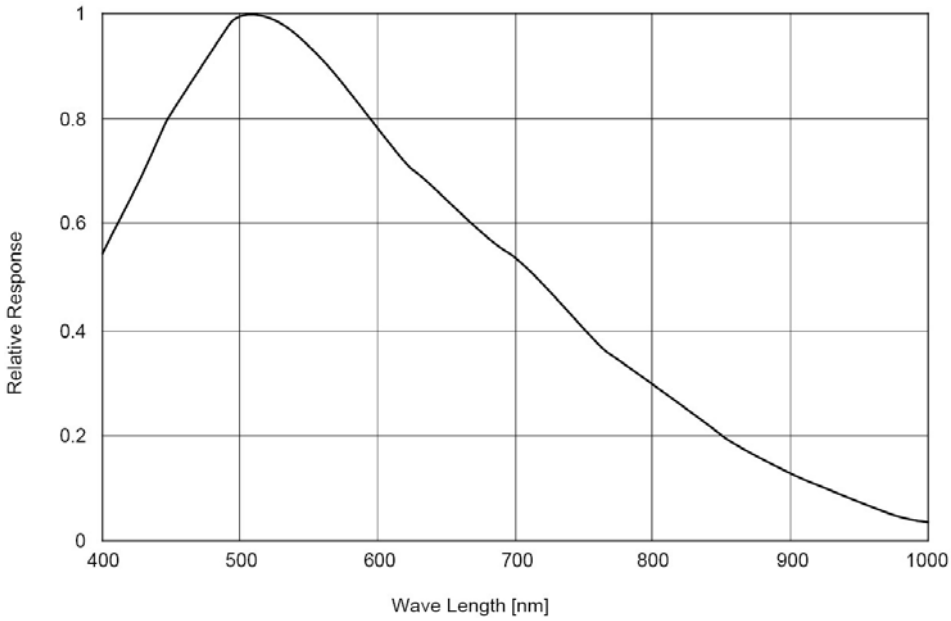
Spectral Sensitivity for FIRE-i 810b



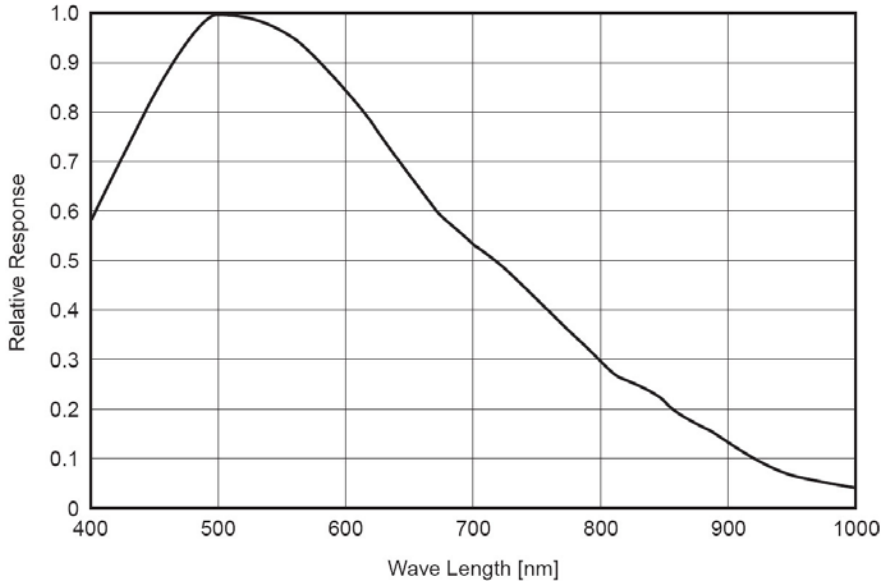
Spectral Sensitivity for Fire-i 701b



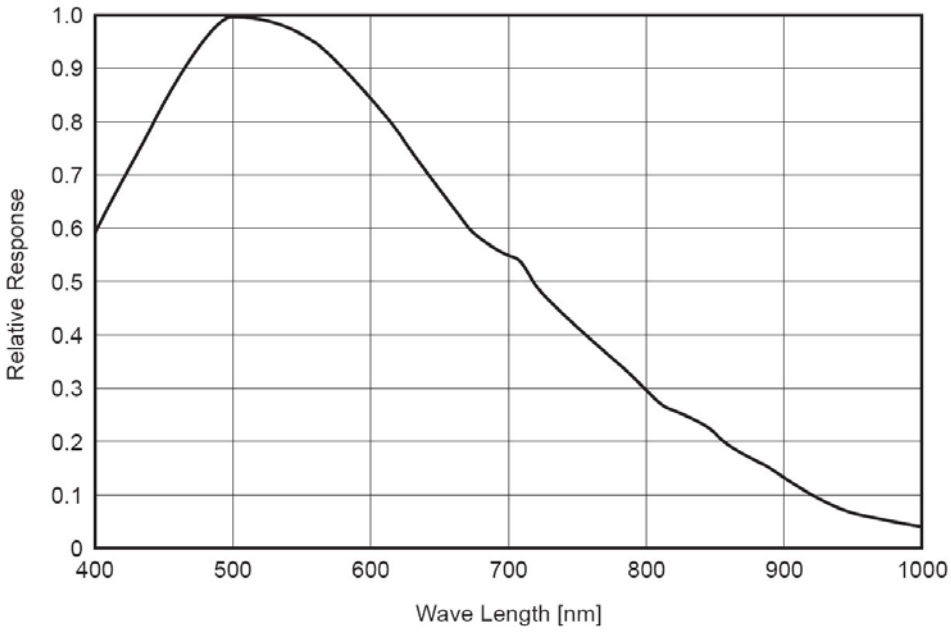
Spectral Sensitivity for Fire-i 702b



Spectral Sensitivity for Fire-i 601b

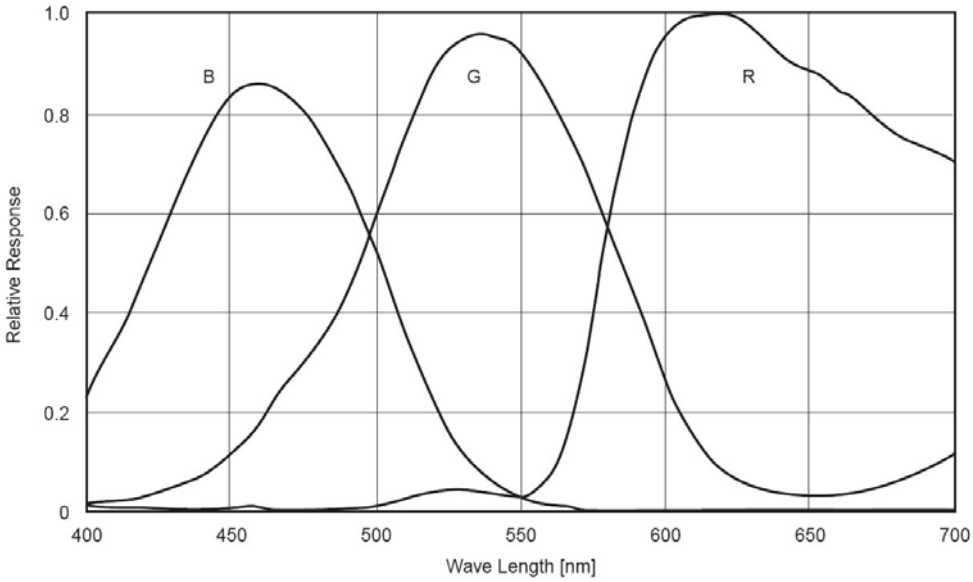


Spectral Sensitivity for Fire-i 511b

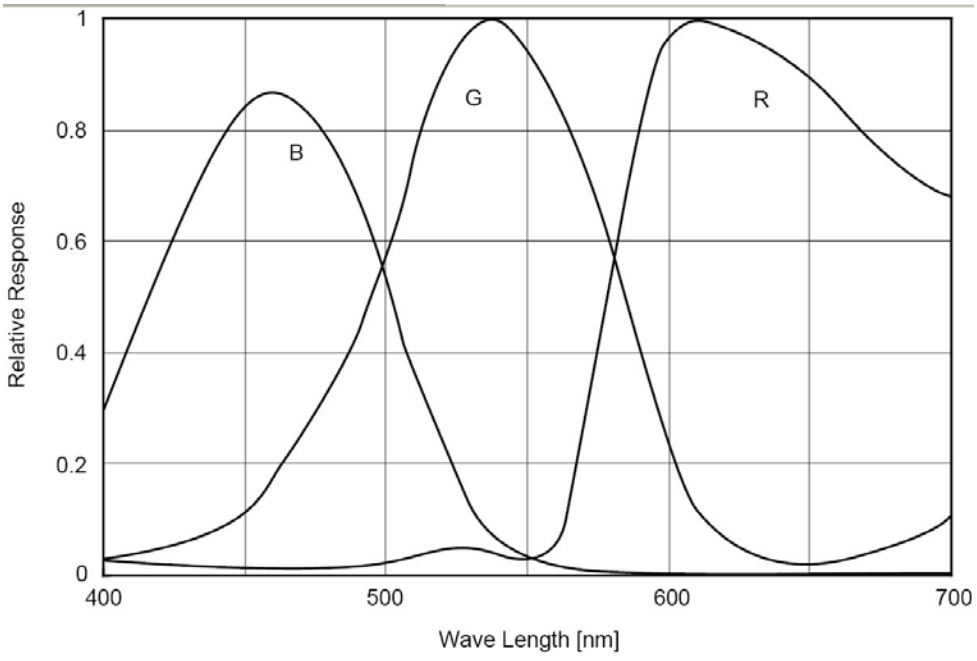


Spectral Sensitivity for Fire-i 501b

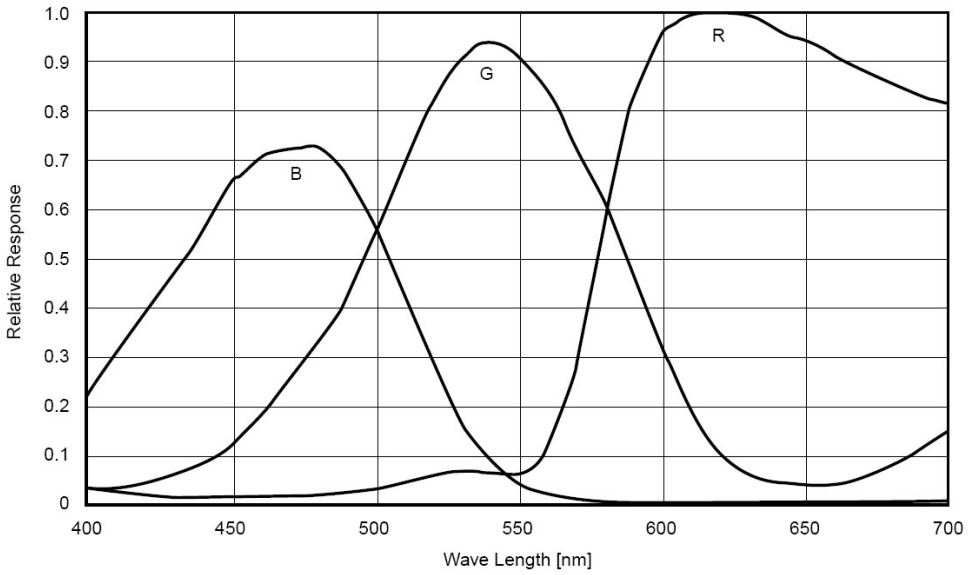
2.3.2. Color Cameras



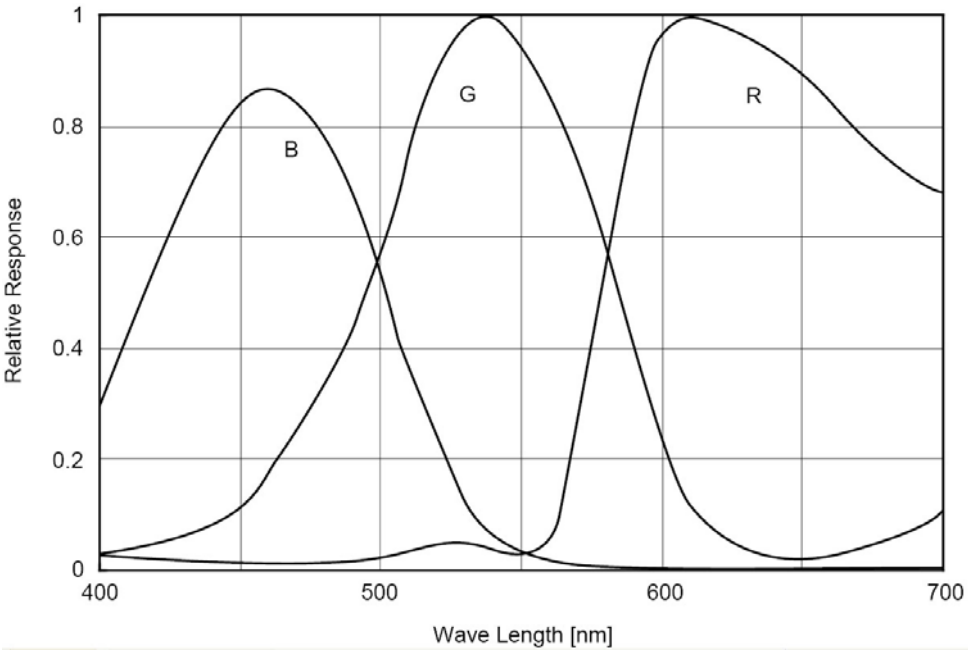
Spectral Sensitivity for Fire-i 810c



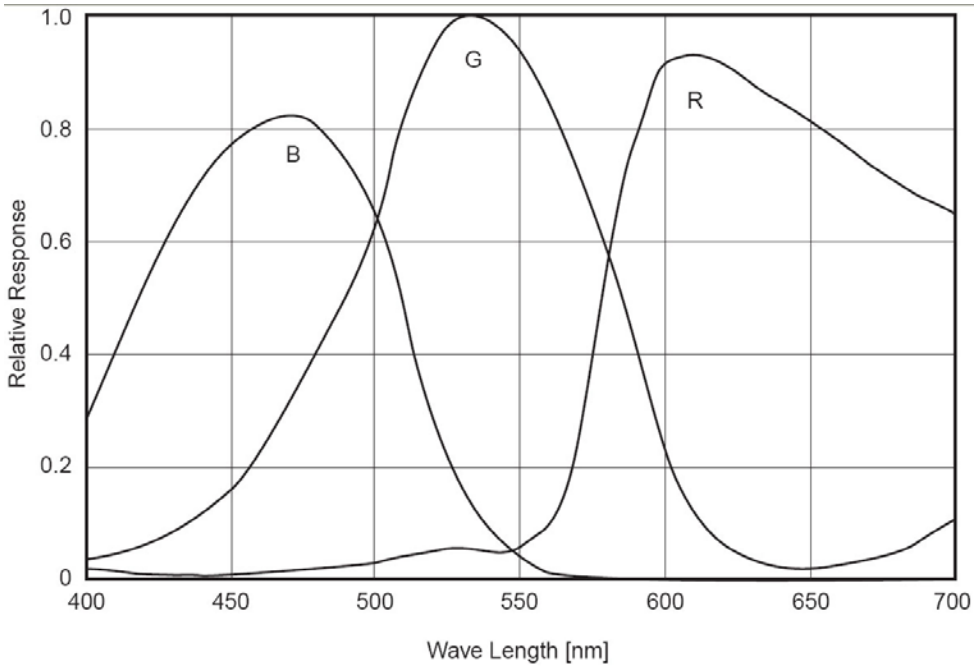
Spectral Sensitivity for Fire-i 701c



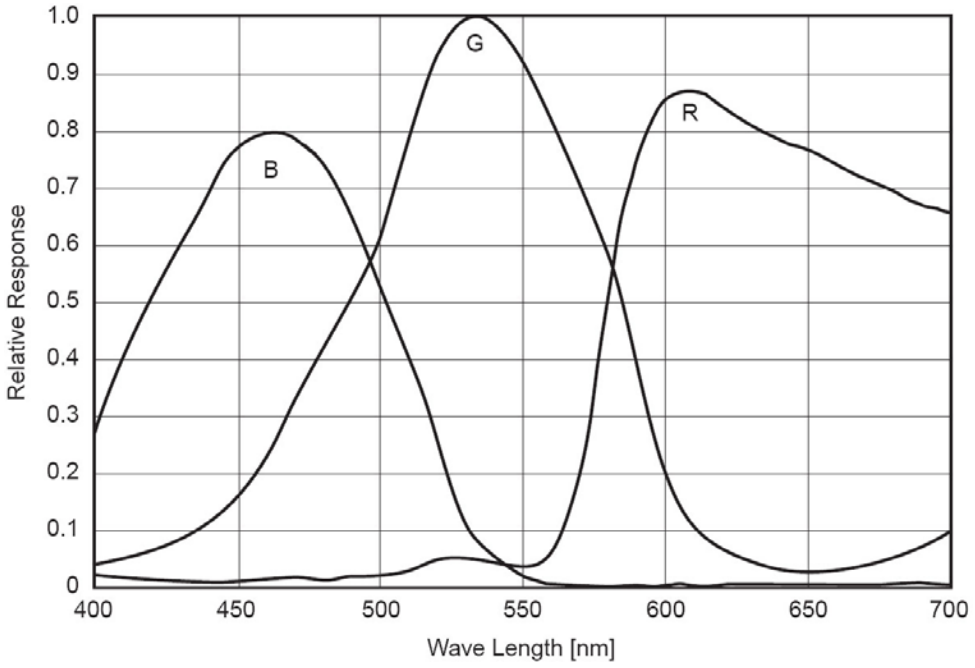
Spectral Sensitivity for Fire-i 702c



Spectral Sensitivity for Fire-i 601c



Spectral Sensitivity for Fire-i 511c



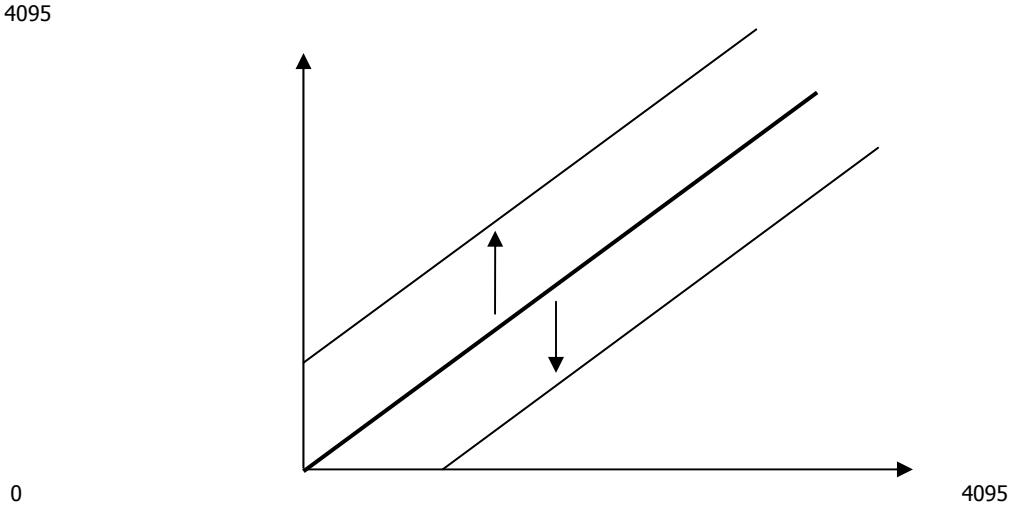
Spectral Sensitivity for Fire-i 501c

3. Basic Operation and Features

The Unibrain cameras employ progressive scan CCD sensor which provides features according to each model. Basic functions and features are similar while each camera of its range would have their specific function support. The cameras- fully support the IIDC V1.31 specification such as registers, video format, mode of operation and control.

3.1. Brightness

Brightness of the camera can be controlled by changing the black level in the camera. The user can inquire the settings of the camera and control using the status control register. Adjust the brightness if the appropriate gradation cannot be obtained due to blurring of black portion of the image. The parameters of Brightness are changed inside the camera. For brightness, its parameters are shifted by the black level.



Inquiry Register

Address	Name	Field	Bit	Description
500h	BRIGHTNESS_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
800h	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..4]	Reserved
		One_Push	[5]	Write '1': begin to work(Self cleared after operation) Read : Value='1' in operation Value ='0' not in operation If A_M_Mode=1, this bit is ignored
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status 0: OFF, 1: ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write : Set the mode Read : Read a current mode 0: Manual, 1:Auto
		-	[8..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

3.2. Auto Exposure Control

The automatic shutter/gain mode is based on a feedback loop which calculates the average pixel luminance. Then the average is compared with the exposure reference value, adjusting shutter and gain accordingly. This feature is similar to "Contrast Control"

Inquiry Register

Address	Name	Field	Bit	Description
504h	AUTO_EXPOSURE_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode(Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Auto_Inq	[6]	Auto mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode(Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
804h	AUTO_EXPOSURE	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.

		-	[2..4]	Reserved
		One_Push	[5]	Write '1' :begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0:OFF, 1:ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1:Auto
		-	[8..19]	Reserved
		Value	[20..31]	Value : Write the value in Auto mode, this filed is ignored. If "ReadOut" capability is not available, read value Has no meaning

3.3. Sharpness

The sharpness control feature may be used to compensate low-pass effects caused for instance by the special color interpolation. If you do not prefer such signal manipulation, you may switch it OFF.

For sharpness control inquiry and status register, follow the same definition as "BRIGHTNESS"

3.4. White Balance

Color models have the white balance feature which can be controlled automatically or manually, U/R (Red/Green) and V/B (Green/Blue) alter the degree to which Red and Blue CCD component pixels are weighed to form composite pixels. In manual mode you can adjust the white balance by altering the Blue and Red Value. One push white balance option can be used for a non-interactive calibration in addition. Currently automatic white balance features are not supported.

Inquiry Register

Address	Name	Field	Bit	Description
50Ch	WHITE_BAL _INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode(Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Auto_Inq	[6]	Auto mode(Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode(Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
80Ch	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write '1' :begin to work(Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0:OFF, 1:ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1:Auto
		-	[8..19]	U Value / B_Value. Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available,, read value has no mean
		Value	[20..31]	V Value / R_Value Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning

3.5. Hue

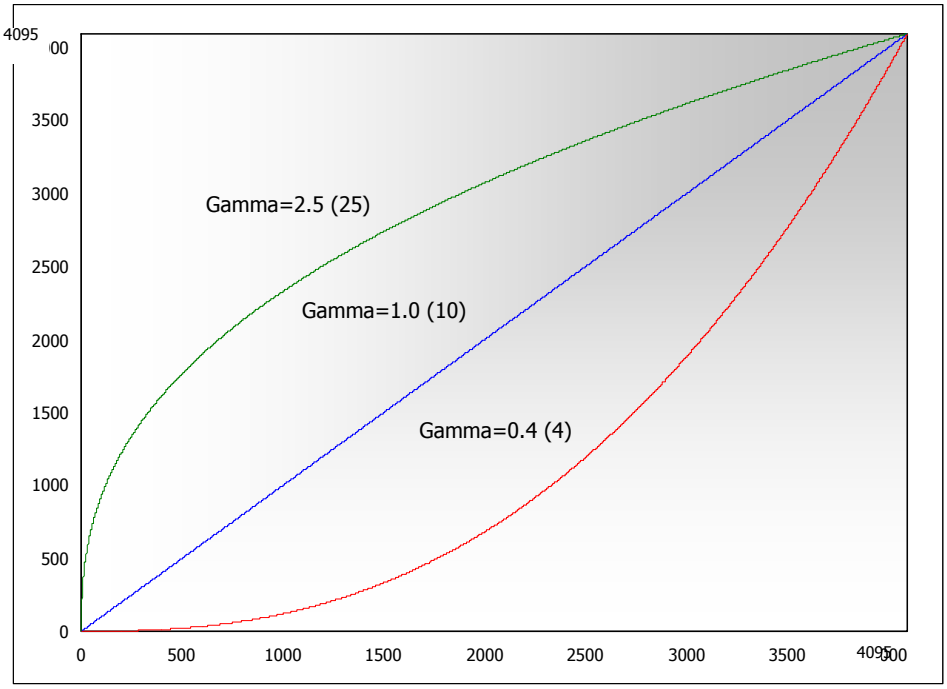
Color models support Hue control which changes the color phase of the picture by adjusting the Green gain. You may use this feature when white balance correction adjusting Red and Blue value does give satisfying result.

3.6. Saturation

The saturation controls the Color saturation in Color models by manually adjusting the level of color from Zero Level (Monochrome). For Saturation control inquiry and status register, follow the same definition as "BRIGHTNESS"

3.7. Gamma

Gamma control defines the function between incoming light level and output picture level. Factory default setting for Gamma is set to 1.0. Gamma value is adjustable in the range of 0.4 ~ 2.5 as per the table below. For Gamma control inquiry and status register, follow the same definition as "BRIGHTNESS"



Gamma Range Table

Gamma Value	4	5	6	7	8	9	10	11	12	13	14
Gamma	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4

Gamma Value	15	16	17	18	19	20	21	22	23	24	25
Gamma	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5

3.8. Shutter

Shutter is defined as the integration time of the incoming light where both Manual and Auto Shutter are supported. The shutter range varies from 1usec ~ 3600 sec. For Shutter control inquiry and status register, follow the same definition as "BRIGHTNESS".

Shutter Speed Value & Range

FireWire Shutter Value(Y)	Increment Step	Shutter Speed Time : T	
		Exposure Time	Range
1 ~ 500	1 us	T= Y us	1us ~ 500us
501 ~ 1000	10 us	T= (Y-500)*10 + 500 us	510us ~ 5500us
1001 ~ 1705	100 us	T= (Y-1000)*100 + 5500 us	5.6ms ~ 76ms
1706 ~ 2399	1 ms	T= (Y-1705) + 76 ms	77ms ~ 770ms
2400 ~ 2902	10 ms	T= (Y-2399)*10 + 770 ms	780ms ~ 5800ms
2903 ~ 3304	100 ms	T= (Y-2902)*100 + 5800 ms	5.9s ~ 46s
3305 ~ 3223	1s	T= (Y-3304)*1000 + 46000 ms	47s ~ 250s
3509 ~ 3843	10s	T=(Y-3508)*10 + 250s	260s ~ 3600s

Shutter Speed Example

Example Shutter Speed Table					
1394 Shutter	Exposure Time	1394 Shutter	Exposure Time	1394 Shutter	Exposure Time
1	1us	1729	100ms	3378	2 min
10	10us	1829	200ms	3438	3 min
100	100us	2129	500ms	3513	5 min
500	500us	2422	1s	3525	7min
550	1ms	2522	2s	3543	10 min
650	2ms	2822	5s	3603	20 min
950	5ms	2944	10s	3663	30 min
1045	10ms	3044	20s	3723	40 min
1145	20ms	3318	60s	3783	50 min
1445	50ms	3323	65s	3843	60 min

3.9. Gain

Gain refers to the amount of the CCD output signal amplification where gain and shutter have similar effect to the image. Manual and Automatic gain mode are supported and manual adjustment is possible for the following range.
For Gain control inquiry and status register, follow the same definition as "BRIGHTNESS".

Camera Type	Step Range	Range in dB	Increment Length
Monochrome Camera	0 ~ 723	0 ~ 27	approx. 0.0345 dB/step
Color Camera	0 ~ 723	0 ~ 25	approx. 0.0319 dB/step
Auto Gain	0 ~ 528	All models except Fire-i 501	
Auto Gain	0 ~ 468	Fire-i 501	

3.10. Trigger & Strobe

The cameras support external trigger by receiving input through the external trigger port. The falling edge and rising edge can be detected as trigger according to the modes it supports as per the following table. A software trigger can also be used that issues a trigger signal via a software command. Software trigger is supported in modes 0, 12, 13, 15.

Trigger	Edge	Rising Edge or Falling Edge	
	Mode	Fire-i 701/702/810	Fire-i 501/511/601
		0, 1, 2, 3, 4, 5, 12, 13, 14, 15	0, 1, 2, 3, 4, 5, 14, 15
	Method	Optocoupler (Photo-coupler)	TTL
	Source	External or Software Trigger	

Inquiry Register

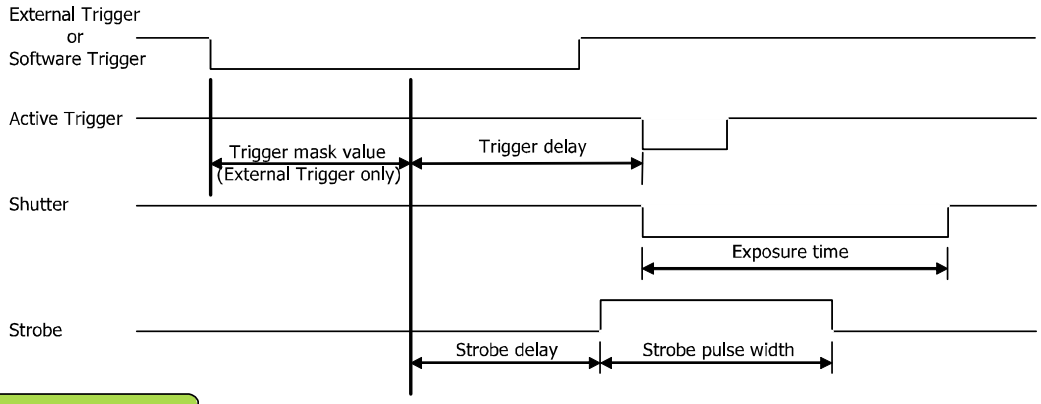
Address	Name	Field	Bit	Description
530h	TRIGGER _INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2..3]	Reserved
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Polarity_Inq	[6]	Capability of changing polarity of trigger input
			[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger Mode0
		Trigger_Mode1_Inq	[17]	Presence of Trigger Mode1
		Trigger_Mode2_Inq	[18]	Presence of Trigger Mode2
		Trigger_Mode3_Inq	[19]	Presence of Trigger Mode3
			[20..31]	Reserved

Control Register

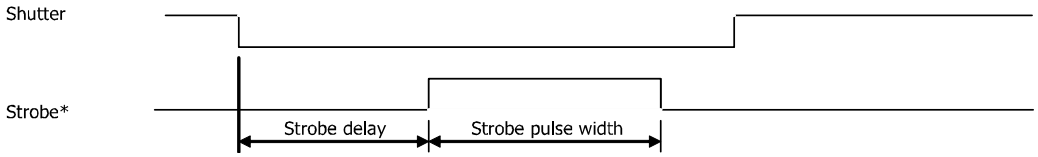
Address	Name	Field	Bit	Description
830h	TRIGGER _MODE	Presence_Inq	0	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF, 1: ON If this bit=0, other fields will be read only.
		Trigger_Polarity	[7]	If Polarity_Inq is "1", Write to change polarity of the trigger input Read to get polarity of trigger input If Polarity_Inq is "0", Read only. (0: Low active input, 1: High active input)
			[8..11]	Reserved
		Trigger_Mode	[12..15]	Trigger mode.(Trigger_Mode_0-15)
			[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required.

3.10.1. Trigger and Strobe Signal relation

At trigger mode



At normal mode



Trigger overlapping function : max trigger frame rate speed up to normal mode frame rate.

Previous version

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

Version 3.10

At trigger mode 0 :

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)} + 200\ \text{usec}}$$

If trigger delay = 0 and trigger noise filer is disabled, trigger max frame rate speeds up to frame rate at normal mode

Caution:

If the next trigger pulse interval is less than (1/fps + trigger_delay(0xf0f00834)+trigger_noise_filter(0xf2f10110) + 200 usec), this trigger pulse may be lost.

At other trigger mode : equal to the previous frame rate.

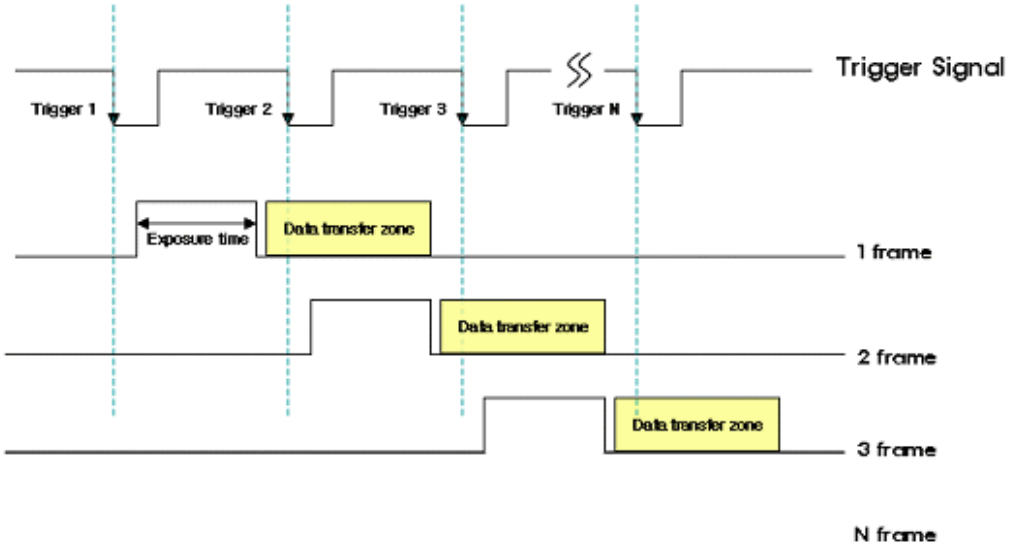
$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

If trigger interval is less than (1/fps + shutter_time), bar noise may be detected.

At trigger mode 0 :

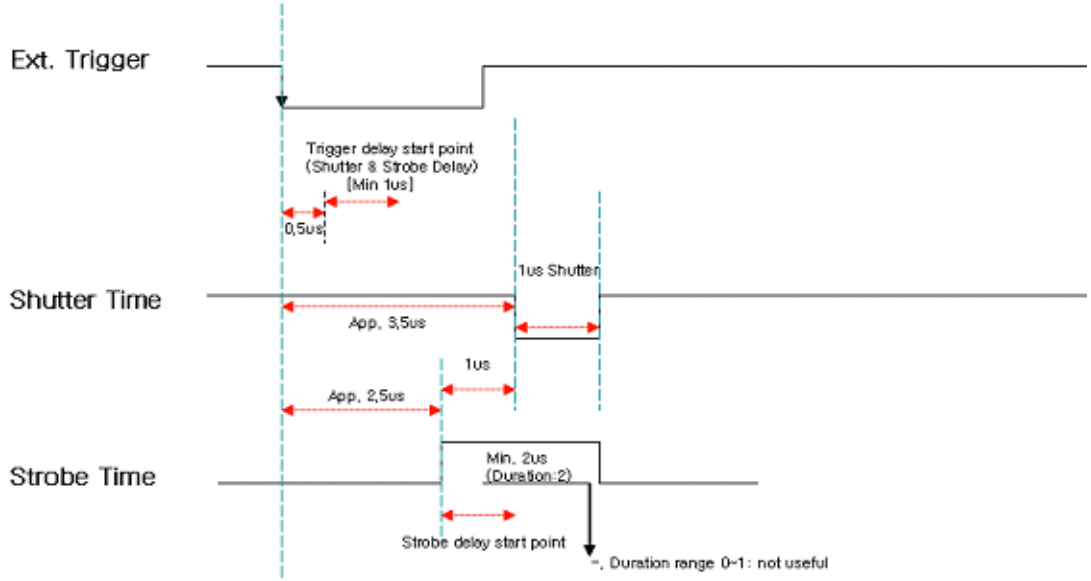
$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)} + 200\ \text{usec}}$$

If trigger delay = 0 and trigger noise filer is disabled, trigger max frame rate speeds up to frame rate at normal mode



3.10.2. Timing Diagram for External Trigger and Shutter and Strobe

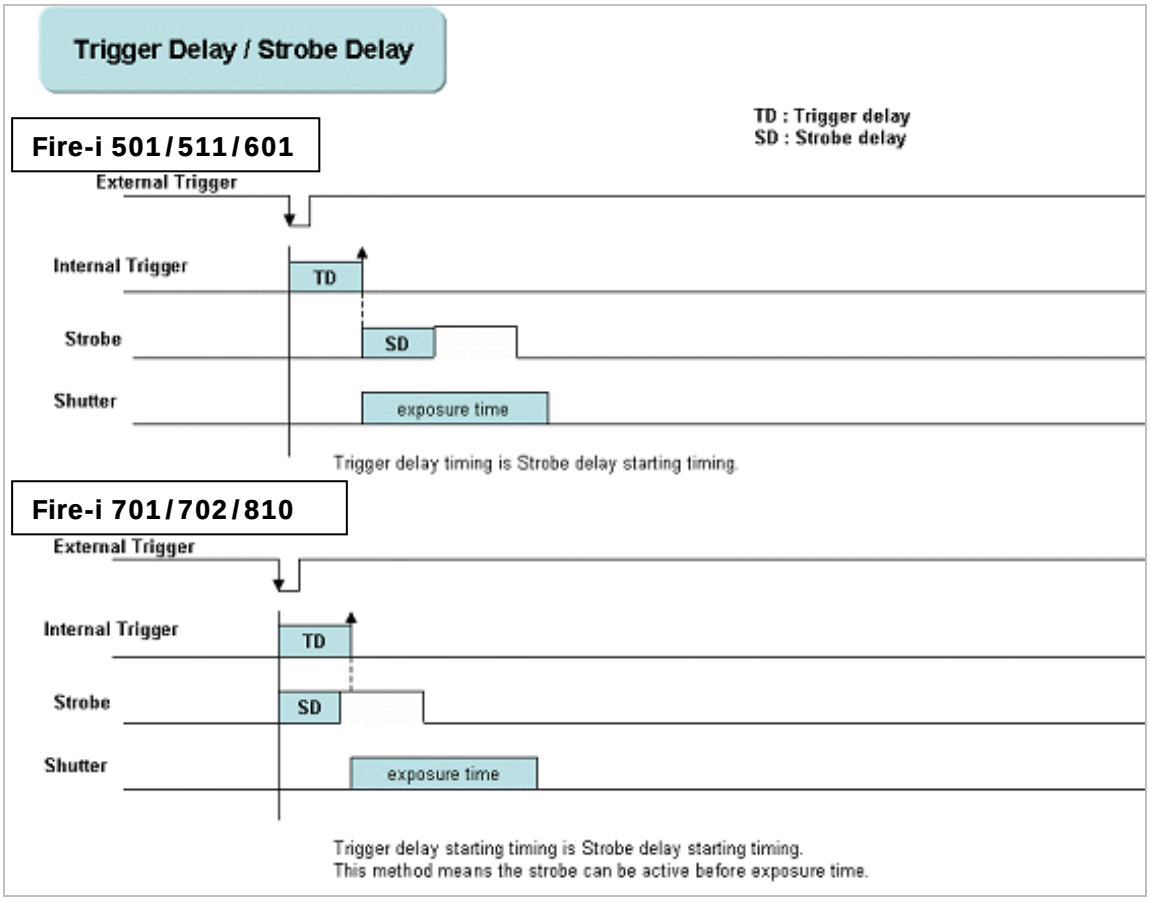
This diagram shows the necessary time related to each signal for External trigger and Shutter and Strobe.



3.10.3. Trigger & Strobe delay

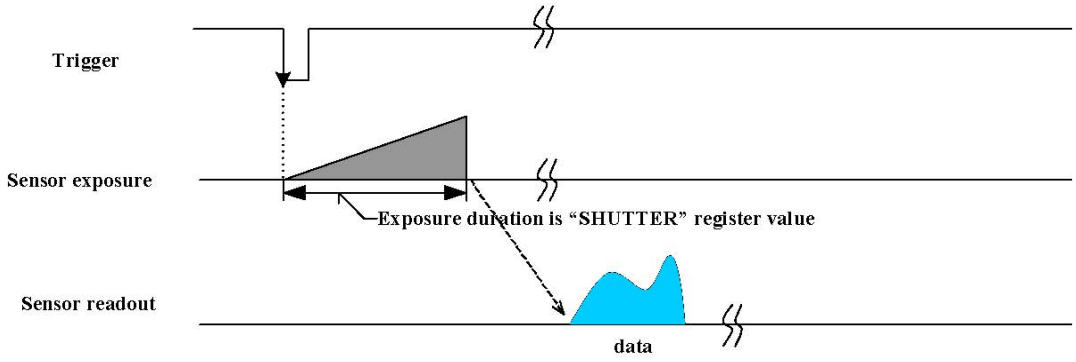
For Fire-i 501/511/601, the strobe signal starting point is almost the same as the exposure starting point.

For Fire-i 701/702/810, the strobe signal starting point is almost the same as the external trigger starting point.



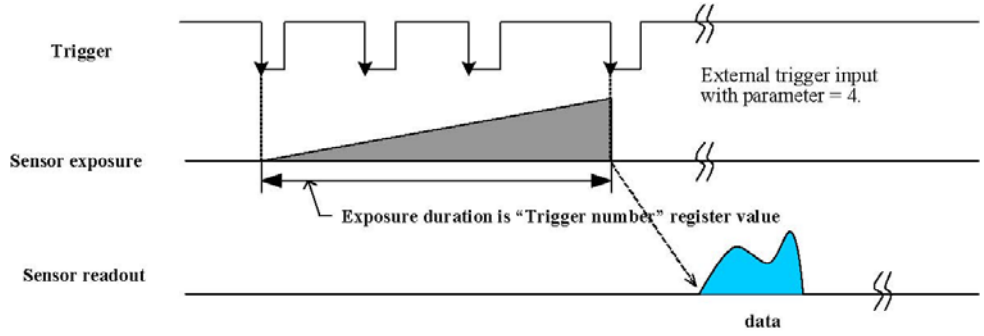
3.10.4. Trigger Mode 0

Camera starts integration of the incoming light from external trigger input falling edge. Integration time is described in the "Shutter" register. No parameter is needed. A Trigger delay is applied to mode 0 for H/W trigger. The Trigger in mode 0 is supported by both H/W trigger and S/W trigger.



3.10.5. Trigger Mode 2

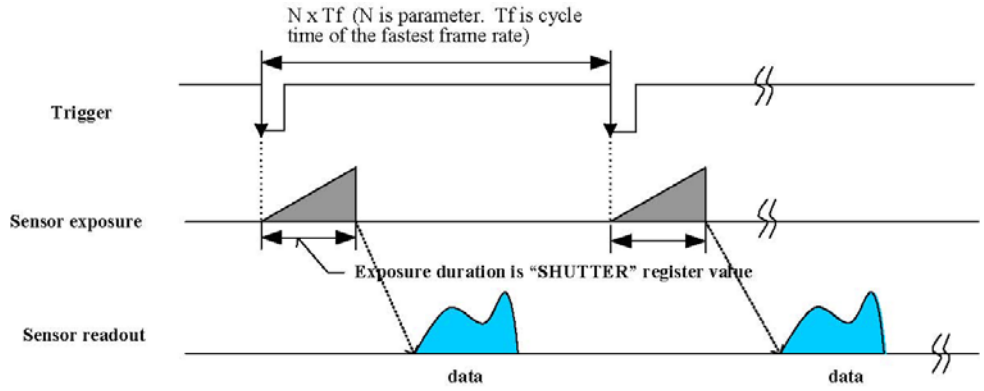
Camera starts integration of incoming light from first external trigger input falling edge. At the N-th (parameter) external trigger input falling edge, integration will be stopped. A Parameter is required and shall be two or more (N >= 2).



3.10.6. Trigger Mode 3

Not supported in Format 7

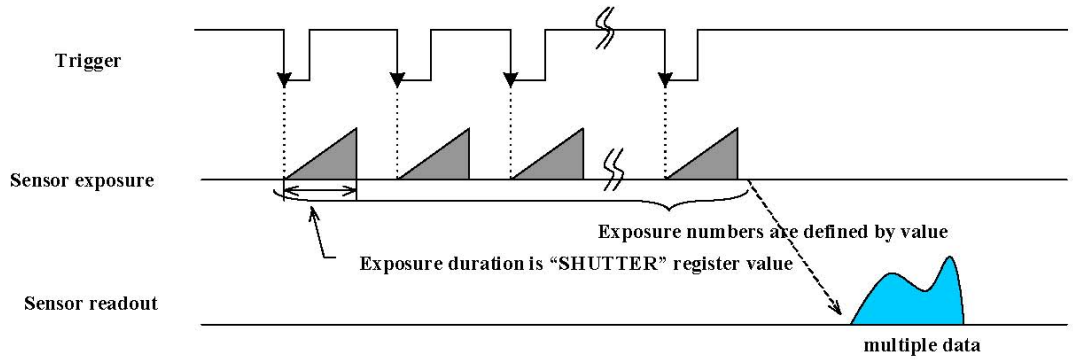
This is an internal trigger mode. Camera will issue a trigger internally and cycle time is N times (parameter) of the cycle time of the fastest frame rate. The Integration time of incoming light is described in the "Shutter" register. A Parameter is required and shall be one or more (N>=1)



3.10.7. Trigger Mode 4

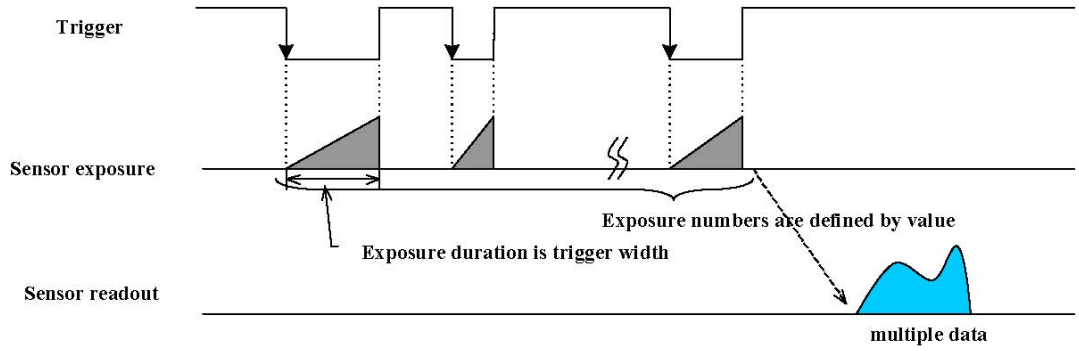
This mode is "multiple shutter preset mode". The Camera starts integration of incoming light from the first external trigger input falling edge and exposes incoming light at shutter time. It repeats this sequence the N-th (parameter) external trigger input falling edge and then finishes integration.

A Parameter is required and shall be one or more. (N >= 1)



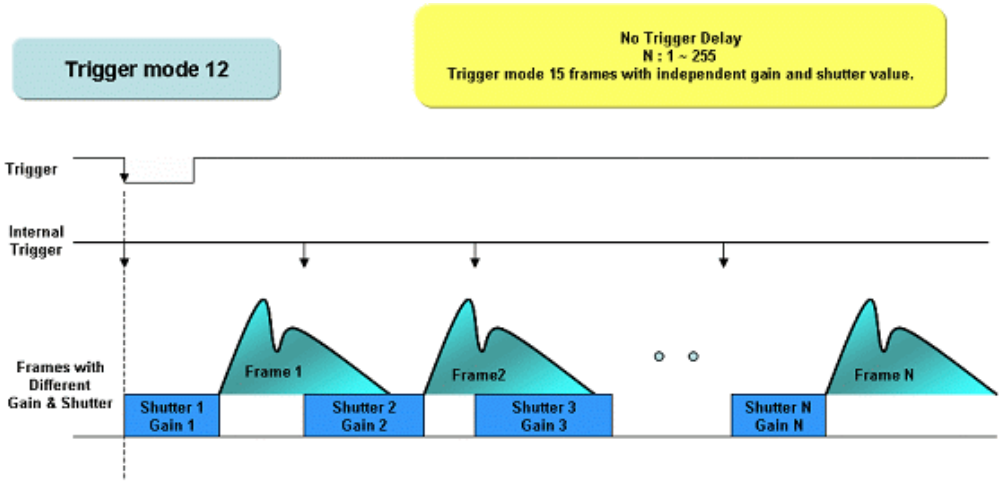
3.10.8. Trigger Mode 5

This mode is "multiple shutter pulse width mode". The camera starts integration of the incoming light from the first external trigger input falling edge and exposes incoming light until the trigger is inactive. It repeats this sequence for the N-th (parameter) external trigger input falling edge and then the integration finishes. A Parameter is required and shall be one or more. (N >= 1)



3.10.9. Trigger Mode 12

Trigger mode 12 is only supported on Fire-i 701/702/810 cameras. The user can capture the multi frame rates with one trigger signal. The users can control the Gain and Shutter by the Parameter Table which has a range from 1 to 255. Mode 12 is supported by both H/W trigger and S/W trigger.



% Caution : Don't change features at trigger 12/13 frame read out. The feature change may be destroy trigger capture frames.

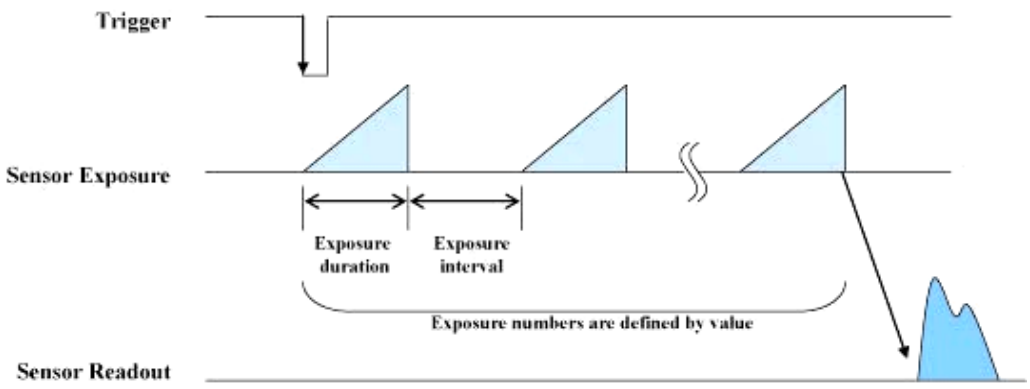
3.10.10. Trigger Mode 13

Trigger mode 13 is only supported on Fire-i 701/702/810 cameras. The user can capture the multi frame rates with one trigger signal. The users can control the Gain and Shutter by the Parameter Table which has a range from 1 to 255. However, we recommend the trigger mode 12. Trigger mode 13 has approximately a 2.5msec delay time so that it is not recommended. Mode 13 is supported by both H/W trigger and S/W trigger.

3.10.11. Trigger Mode 14

This mode is "preset multiple shutter mode with a single trigger".

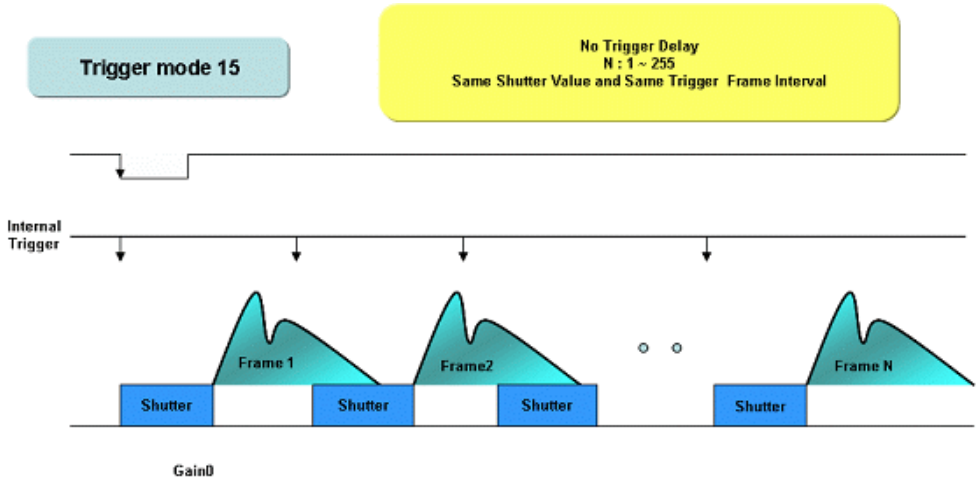
This mode is similar to "trigger mode 4" but the difference is that all the parameter is preset by the users using only a single trigger. "Exposure Number", "Exposure Duration", and "Exposure Interval" are the parameters required for this mode. However, the exposure duration and interval in each multiple shutter is equal and cannot be different. Exposure duration & interval is defined by the user defined 1394 address (0xF2F10114)



3.10.12. Trigger Mode 15

Trigger Mode 15 provides the new functions which are available in latest (end of 2007) firmware.

Users can capture as many images as they want with one external trigger signal. This mode is called 'One-trigger Multi-frames'. For mode 15, the value of the shutter time should be fixed. Mode-15 is supported by both H/W trigger and S/W trigger.



3.11. Strobe Control Register

Base Address: 0xF2F23000h

Address	Name	Field	Bit	Description
000h	Strobe_CTRL_Inq	Strobe_0_Inq	[0]	Presence of strobe 0 signal
		Strobe_1_Inq	[1]	Presence of strobe 1 signal
		Strobe_2_Inq	[2]	Presence of strobe 2 signal
		Strobe_3_Inq	[3]	Presence of strobe 3 signal
		-	[4..31]	Reserved
004h . . 0FCh	Reserved			
100h	Strobe_0_Inq	Presence_Inq	[0]	Presence of this function
		-	[1..3]	Reserved
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this function ON and OFF
		Polarity_Inq	[6]	Capability of changing polarity of the signal
		-	[7]	Reserved
		Min_Value	[8..19]	Minimum value of this function control
		Max_Value	[20..31]	Maximum value of this function control
104h	Strobe_1_Inq	Same definition to Strobe_0_Inq		
	Strobe_2_Inq	Same definition to Strobe_1_Inq		
	Strobe_3_Inq	Same definition to Strobe_2_Inq		
110h . . 1FCh	Reserved			
200h	Strobe_0_Cnt	Presence_Inq	[0]	Presence of this function 0:N/A 1: Available
		-	[1..5]	Reserved
		ON_OFF	[6]	Write : ON or OFF this function Read: read a status 0: OFF, 1: ON if this bit=0, other fields will be read only
		Signal Polarity	[7]	Select signal polarity If Polarity_Inq is "1" Write to change polarity of the strobe output Read to get polarity of the strobe output If Polarity_Inq is "0" Read only (0: lowa active output, 1: High active output)
		Delay_Value	[8..19]	Delay after start of exposure until the strobe signal asserts
		Duration_Value	[20..31]	Duration of the strobe signal A value 0 means dessert at the end of exposure function if required.
204h	Strobe_1_Cnt	Same definition to Strobe_0_Inq		
208h	Strobe_2_Cnt	Same definition to Strobe_1_Inq		
20Ch	Strobe_3_Cnt	Same definition to Strobe_2_Inq		
210h . . 2FFh	Reserved			

3.12. Trigger Delay Control

Based on external triggers users can delay image acquisition by the trigger delay control feature. Fire-i camera series support the IIDC V1.31 specification for trigger delay control as per the following tables.

Trigger Delay Index (Y)	Incremental Step	Trigger Delay Time : T	
		Delay Time	Range
1 ~ 500	1 us	T = Y us	1us ~ 500 us
501 ~ 1000	10 us	T = (Y - 500) * 10 + 500	510 us ~ 5500 us
1001 ~ 1445	100 us	T = (Y - 1000) * 100 + 5500 us	5.6 ms ~ 50 ms

Trigger Delay Example Table

Index	1	10	100	500	550	650	950	1045	1145	1445
Time	1 us	10 us	100 us	500 us	1 ms	2 ms	5 ms	10 ms	20 ms	50ms

Inquiry Register

Address	Name	Field	Bit	Description
534h	TRIGGER_DLY_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
834h	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..5]	Reserved
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status 0: OFF, 1:ON If this bit=0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

3.13. Strobe Delay / Duration Table

The table shows the strobe index by increment step through the strobe delay time and the strobe duration time. The Increment Step is different according to strobe index. Fire-i 501/511/601 and Fire-i 701/702/810 have different range for strobe delay and duration in the index table.

Fire-i 501/511/601

Strobe Delay/Duration Table				
Strobe Index(Y)	Increment Step	Strobe Delay Time : T		
		Delay Time	Duration Time	Range
0		0us	N.A	
1		1us	N.A	
2		2us	2us	
3~250	1us	T=Y us	T=Y us	3us~250us
251~489	250us	T=(Y-250)*250us+250us	T=(Y-250)*250us+250us	500us~60ms

Strobe Delay/Duration Index	Strobe Delay Time	Strobe Duration Time
0	0us	N.A
1	1us	N.A
2	2us	2us
10	10us	10us
100	100us	100us
250	250us	250us
253	1ms	1ms
257	2ms	2ms
269	5ms	5ms
289	10ms	10ms
329	20ms	20ms
449	50ms	50ms
489	60ms	60ms

Fire-i 701/702/810

Strobe Delay Table			
Strobe Index(Y)	Increment Step	Strobe Delay Time : T	
		Delay Time	Range
0	1us	0us	0us
1		1us	1us
2		2us	2us
3~250		T=Y us	3us~250us
251~3900		T=Y us	251us~3900us

Strobe Duration Table			
Strobe Index(Y)	Increment Step	Strobe Duration Time : T	
		Duration Time	Range
0	N.A	N.A	N.A
1	N.A	N.A	N.A
2	1us	2us	2us
3~250	1us	T=Y us	3us~250us
251~489	250us	T=(Y-250)*250us+250us	500us~60ms

Delay Index(Y)	Strobe Delay Time
0	0us
1	1us
2	2us
10	10us
100	100us
200	200us
300	300us
500	500us
800	800us
1000	1000us
2000	2000us
3000	3000us
3900	3900us

Duration Index (Y)	Strobe Duration Time
0	N.A
1	N.A
2	2us
10	10us
100	100us
250	250us
253	1ms
257	2ms
269	5ms
289	10ms
329	20ms
449	50ms
489	60ms

3.14. Optical Filter Control

Optical Filter control allow user to change the optical filter of the camera lens function. You can change the Bayer patterns by moving the starting position which to output pixel data by one position up, down, right or left. (Only for color models)

Inquiry Register

Address	Name	Field	Bit	Description
58Ch	OPTICAL_FILTER_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

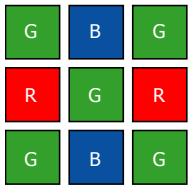
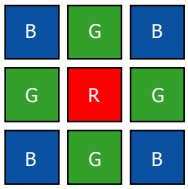
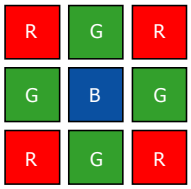
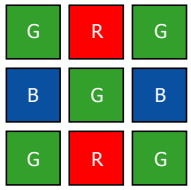
Status Control Register

Address	Name	Field	Bit	Description
88Ch	OPTICAL_FILTER	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..5]	Reserved
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status, 0: OFF, 1:ON If this bit=0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

3.15. Color (Bayer) Patterns Conversion

Color sensors capture images through a optical low pass filter placed over the individual pixel in Bayer mosaic layout. Imaged data are transferred by passing color processing which can save bandwidth gaining higher frame rate and flexibility of applying different Bayer Pattern on the PC side.

Obtained Images can be processed in either of the following 4 different conversion algorithm can on the PC side.

Modes	Mode 0 GB/RG	Mode 1 BG/GR	Mode 2 RG/GB	Mode 3 GR/BG
Color(Bayer) Pattern				

4. Advanced Features

4.1. Binning Mode

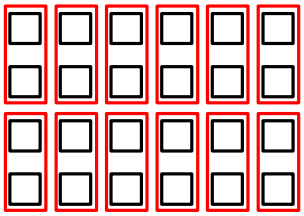
(B/W models and Fire-i 810c Model)

Binning is defined as reading neighboring pixel and combining directly from the CCD of the camera. Binning is has an advantage in the following situation and my further be used in various applications. Relative binning mode per camera model is described in each camera specification.

- Low Light Operation: Combining neighboring pixel increases the area of the CCD receiving light thus may obtain brighter picture in low light condition with possible noise reduction.
- High Frame Rate Operation: Vertical Binning accelerates the speed of CCD data transfer rate by combining multiple vertical lines per single horizontal line of the CCD resulting in a significant gain in frame rate.

4.1.1. Vertical Binning

Vertical binning combines CCD pixels neighboring vertically to a single pixel increasing light sensitivity of the camera. Since CCD acquire data horizontally, multiple lines are acquired in case of vertical binning which results significant speed gain. Thus the vertical resolution is reduced and due to the increased CCD area over exposure may occur which may require adjustment.

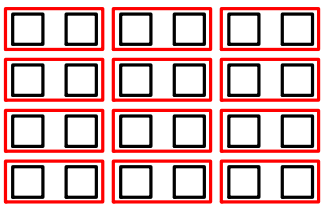


1x2 Vertical Binning

Example

4.1.2. Horizontal Binning

Horizontal binning combines CCD pixel neighboring horizontally to a single pixel increasing light sensitivity of the camera. However due to the nature of CCD transferring each horizontal line at a time there is no speed gain in horizontal binning. However light sensitivity increase may occur, due to the increased CCD area similar to vertical binning and horizontal resolution is reduced.

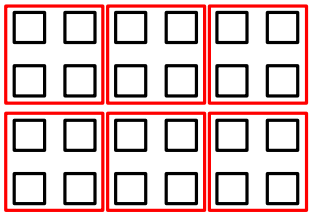


2x1 Horizontal Binning

Example

4.1.3. Full Binning

Full binning mode can be obtained by combining vertical and horizontal binning. First horizontal pixels are combined followed by a vertical conjunction of these pixels. This would increase light sensitivity by a factor of 4 in case of 2 x 2 (Horizontal x Vertical) binning. However as described above, only vertical binning would result speed gain while horizontal binning gives no speed gain thus speed gain results as similar to vertical binning. Resolution in this mode would be reduced both horizontally and vertically.



2x2 Full Binning

Example

4.2. Partial Scan

Cameras are defined of a certain resolution according to the image sensor while often a certain region maybe of an interest to the user. The partial scan mode provides the function to provide output of a certain region of interest (ROI) which may have advantage in data transfer speed resulting faster operation. As described in binning mode speed gain would occur only in vertical resolution decrease. Partial Scan is supported only in Format 7 by setting the following registers described in the IIDC1.31 specification. Unit size of the partial scan is described in the camera specification which user must consider in increment configuration.

IMAGE_POSITION & IMAGE_SIZE register

Left = Hposunit * n1

Top = Vposunit * m1

Width = Hunit * n2

Height = Vunit * m2

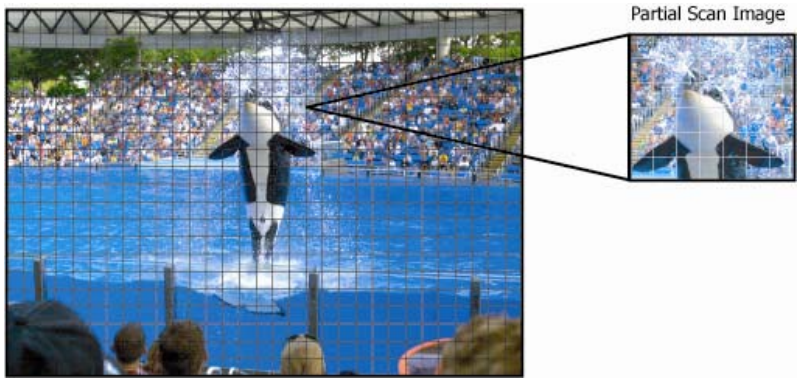
Left + Width < = Hmax

Top + Height < = Vmax

(n1,n2, m1, m2 are integer)

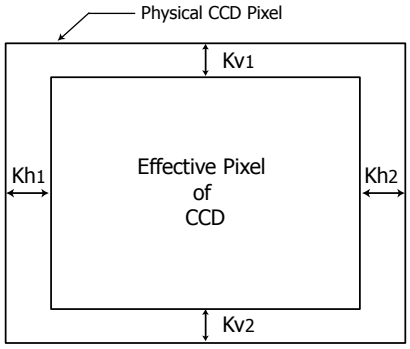
0 - 7	8 – 15	16 – 23	24 - 31
Left		Top	
0 - 7	8 – 15	16 – 23	24 - 31
Width		Height	

Initial Values	System Dependant
Read Values	Last Update Value
Write Effect	Stored



4.3. Pan/Tilt

Pan/Tilt is a function used to move a camera up and down or left and right. However unlike the mechanical Pan /Tilt which is carried out by physically moving the camera up and down, this functions by using smaller video mode than the CCD's effective pixel and moving the image up and down. This results of a cut off pixel from the whole image which user can specify by the Pan/Tilt command. Pan/Tilt range and values depend on the characteristic of each CCD used in the camera respectively as per the following tables. Note that at Format 7 mode, the pan/tilt value must be set at non-format 7 mode before operation.



$Kh = Kh_1 + Kh_2$ $Kv = Kv_1 + Kv_2$

Pan/Tilt Details for Fire-i 501/511

Image Size	Movement	Fire-i 501b/511b Kh =12, Kv=12		Fire-i 501c/511c Kh=8, Kv=10	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 492	326	160 ~ 488	324
	Tilt	120 ~ 372	246	120 ~ 370	242
640 x 480	Pan	320 ~ 332	326	320 ~ 328	324
	Tilt	240 ~ 252	246	240 ~ 250	242
640 x 480 Format 7 Mode 0	Pan	320 ~ 332	326	320 ~ 328	324
	Tilt	240 ~ 252	246	240 ~ 250	242
320 x 240 Format 7 Mode 1	Pan	320 ~ 332	326	-	-
	Tilt	240 ~ 252	246	-	-
640 x 240 Format 7 Mode 2	Pan	320 ~ 332	326	-	-
	Tilt	240 ~ 252	246	-	-

Pan/Tilt Details for Fire-i 601

Image Size	Movement	Fire-i 601b Kh=8, Kv=8		Fire-i 601c Kh=8 Kv=8	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 872	516	160 ~ 872	516
	Tilt	120 ~ 656	388	120 ~ 656	388
640 x 480	Pan	320 ~ 712	516	320 ~ 712	516
	Tilt	240 ~ 536	388	240 ~ 536	388
1024 x 768	Pan	400 ~ 632	516	400 ~ 632	516
	Tilt	300 ~ 476	388	300 ~ 476	388
1024 x 768 Format 7 Mode 0	Pan	512 ~ 520	516	512 ~ 520	516
	Tilt	384 ~ 392	388	384 ~ 392	388

512 x 384 Format 7 Mode 1	Pan	512 ~ 520	516	-	-
	Tilt	384 ~ 392	388	-	-
1024 x 384 Format 7 Mode 2	Pan	512 ~ 520	516	-	-
	Tilt	384 ~ 392	388	-	-

Pan/Tilt Details for Fire-i 701 & Fire-i 702

Image Size	Movement	Fire-i 702b/ Fire-i 701b Kh=0, Kv=0		Fire-i 702c/ Fire-i 701c Kh=0, Kv=0	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 1232	694	160 ~ 1232	694
	Tilt	120 ~ 920	518	120 ~ 920	518
640 x 480	Pan	320 ~ 1072	694	320 ~ 1072	694
	Tilt	240 ~ 800	518	240 ~ 800	518
800 x 600	Pan	400 ~ 992	694	400 ~ 992	694
	Tilt	300 ~ 740	518	300 ~ 740	518
1024 x 768	Pan	512 ~880	694	512 ~880	694
	Tilt	384 ~ 656	518	384 ~ 656	518
1280 x 960	Pan	640 ~ 752	694	640 ~ 752	694
	Tilt	480 ~ 560	518	480 ~ 560	518
1392 x 1040 Format 7 Mode 0	Pan	-	694	-	694
	Tilt	-	518	-	518
692 x 516 Format 7 Mode 1	Pan	-	694	-	-
	Tilt	-	518	-	-
1388 x 516 Format 7 Mode 2	Pan	-	694	-	-
	Tilt	-	518	-	-

Pan/Tilt Details for Fire-i 810

Image Size	Movement	Fire-i 810b Kh=22, Kv=34		Fire-i 810c Kh=20, Kv=34	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 1462	810	160 ~ 1460	810
	Tilt	120 ~ 1114	616	120 ~ 1114	616
640 x 480	Pan	320 ~ 1302	810	320 ~ 3000	810
	Tilt	240 ~ 994	616	240 ~ 994	616
800 x 600	Pan	400 ~ 1222	810	400 ~ 1220	810
	Tilt	300 ~ 934	616	300 ~ 934	616
1024 x 768	Pan	512 ~ 1110	810	512 ~ 1108	810
	Tilt	384 ~ 850	616	384 ~ 850	616
1280 x 960	Pan	640 ~ 982	810	640 ~ 980	810
	Tilt	480 ~ 754	616	480 ~ 754	616
1600 x 1200	Pan	800 ~ 822	810	800 ~ 820	810
	Tilt	600 ~ 634	616	600 ~ 634	616
1600 x 1200 Format 7 Mode 0	Pan	800 ~ 822	810	800 ~ 820	810
	Tilt	600 ~ 634	616	600 ~ 634	616
800 x 600 Format 7 Mode 1	Pan	800 ~ 822	810	800 ~ 820	810
	Tilt	600 ~ 634	616	600 ~ 634	616
1600 x 600 Format 7 Mode 2	Pan	800 ~ 822	810	800 ~ 820	810
	Tilt	600 ~ 634	616	600 ~ 634	616

4.4. One-Shot and Multi-Shot

This camera supports One-Shot and Multi-Shot features. The camera should be in a Iso_disabled mode before the execution of those commands. If the camera is Iso_enabled mode already, those commands are ignored.

One-Shot (grab one frame) and Multi-Shot (grab 1 ~ 65,535 frames) can be used combined with a hardware trigger which grabs either one frame or multi frame according to the command respectively.

The command can be executed configuring the following registers.

One-Shot		**Multi-Shot**	
Address	F0F0061CH	Address	F0F0061CH
Data	80000000h	Data	4000nnnh

nnnn is the number of frames output which can be from any number between 0001h ~ FFFFh.(1~ 65,535)

Priority of the command execution is as follows. Continuous → One-shot → Multi-shot.

When a command with higher priority is being executed the command with lower priority shall be ignored.

4.5. Multi-Camera Auto-sync

Not supported in 3.75 fps

In applications incorporating multi camera, there is often a need to synchronize the cameras. Multi-Camera Auto Synchronization is supported utilizing the FireWire bus time cycle register which is connected on the same FireWire bus. A maximum of 3 cameras can be auto synchronized.

The video mode of the camera must be set within the limit of a single FireWire bus bandwidth of 400Mbps. Also the maximum shutter value must be set as per the table below not exceeding the FireWire bus cycle time. Jitter may occur due to CPU operation timing.

FPS	**Fire-i 501/511**		**Fire-i 601**		**Fire-i 701/702**		**Fire-i 810**	
	Max Shutter		Max Shutter		Max Shutter		Max Shutter	
	Value	Time	Value	Time	Value	Time	Value	Time
60	1110	16.5ms	-	-	-	-	-	
30	1276	33.1ms	1270	32.5ms	-	-	-	-
15	1608	66.3ms	1598	65.3ms	1612	66.7ms	1606	66.1ms
7.5	1760	131ms	1758	129ms	1761	132ms	1760	131ms
3.75	1893	264ms	1889	260ms	1895	266ms	1893	264ms

To utilize Auto-sync, please set Bit 31 to Auto-sync Enable, and then check the Bit 27 to verify whether it is ready. Please refer the details as the following table.

0xF2F10018	**Auto-Sync Mode control register** Bit 31 : auto sync enable Bit 30 : SIO enable mode (0 : custom mode, 1 : IIDC v1.31) Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)	Read/Write

4.6. Asynchronous Broadcasting

Asynchronous broadcasting is supported where using node 63 of the FireWire bus is used as a target node for asynchronous write request. This enables all the cameras to be triggered by software simultaneously. By utilizing Asynchronous Broadcasting user can execute and control all the cameras on the same FireWire bus at the same time with a single command.

4.7. Memory Channel Save / Load

The settings of the camera features (Shutter, gain, etc.) and video modes can be stored in a non-volatile memory. The camera supports 16 memory channels as per the table below to conveniently save and load different features as well as video modes. Channel 0 is the factory default (preset) and Channels 1 ~ 4 can be used for saving camera configuration. Channels 5 ~ 15 are used for resolution, mode and frame rate plus saving other features.

Address	Name	Bit	Description
618h	Memory_Save	[0]	Saves the current setting
		[1..31]	Reserved
Address	Name	Bit	Description
620h	Mem_Save_Ch	[0]	Factory Default Setting Cannot overwrite
		[1..4]	Write Channel for Memory Save for Channel 1 ~ 4 (Only for Features)
		[5..15]	Write Channel for Memory Save for Channel 5 ~ 15 (For Features, Format and Mode Save)
Address	Name	Bit	Description
624h	Cur_Save_Ch	[0]	Read and Load Factory Default Setting
		[1..4]	Read and Load Memory Channel 1 ~ 4
		[5..15]	Read and Load Load Memory Channel 5 ~ 15

User Defined FireWire Register Control

The values saved in the channel are user defined and they can be set as default values at power-on of the camera.

Address	Description(bit : msb*)	Read/Write
0xF2F1011C	**Power on default memory channel** Bit 0 ~ Bit 3 : power on initial memory channel	Read/Write
	Egaxmple: Channel 5 is to be set the default mode at power-on. ➔add F2F1011C read -➔ **5**0000000 write	

4.8. Time Stamp Register

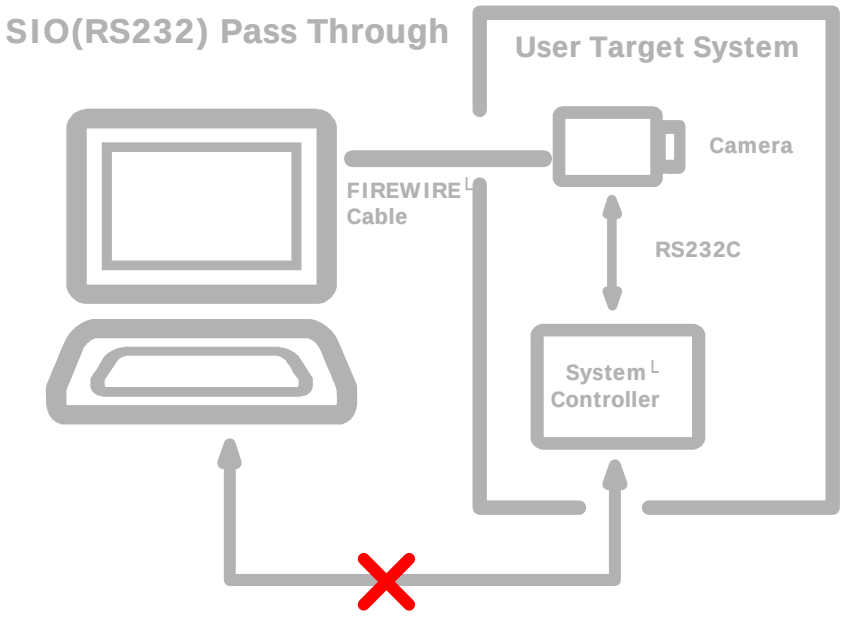
The Time stamp register may be inquired from the fireWire bus. CYCLE_TIME register can be configured as shown in the table below. You may also get the same value from the user defined, but we recommend using this.

<table>
<tr><th>Address</th><th>Description(bit : msb*)</th><th>Read/Write</th></tr>
<tr><td>0xF0000200</td><td>
CYCLE_TIME
<table>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td></tr>
<tr><td colspan="7">SECONDS COUNT</td><td colspan="13">CYCLE COUNT</td><td colspan="12">CYCLE OFFSET</td></tr>
</table>
<table>
<tr><th>Bit Number</th><th>Bit Name</th><th>Function</th><th>DIR</th><th>Description</th></tr>
<tr><td>0 - 6</td><td>SECONDS COUNT</td><td>Seconds Count</td><td>R/W</td><td>1 Hz cycle timer counter</td></tr>
<tr><td>7 - 19</td><td>CYCLE COUNT</td><td>Cycle Count</td><td>R/W</td><td>8,000 Hz cycle timer counter</td></tr>
<tr><td>20 - 31</td><td>CYCLE OFFSET</td><td>Cycle Offset</td><td>R/W</td><td>24.576 MHz cycle timer counter</td></tr>
</table>
</td><td>Read</td></tr>
</table>

4.9. Serial Interface

Fire-i industrial cameras are equipped with SIO (Serial input/output) feature described in the IIDC 1.31 specification. By using the serial interface, users can execute commands by writing data in a specific address in the FireWire address range. SIO can be further used as a RS232 interface which supports pass through and custom commands.

4.9.1. SIO Pass through Scheme



4.9.2. SIO Registers

Base address: F2F22000h, default baud rate is 57600

Address	Name	Field	Bit	Description
000h	Serial_Mode_Reg	Baud Rate	[0..7]	Baud Rate Setting Write : Set baud rate Read : Get current baud rate 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200bps 10: 230400bps Other value reserved.
		Char_Length	[8..15]	Character length setting Write: Set data length(must not be 0) Read : Get data length 7: 7 bits 8: 8 bits Other values reserved.
		Parity-	[16..17]	Parity setting Write : Set Parity Read : Get current parity 0: None 1 : Odd 2 : Even
		Stop_bit	[18..19]	Stop bits Write : Set stop bit Read : Get current stop bit 0: 1 1: 1.5 2: 2.
		-	[20..23]	Reserved
		Buffer_Size_Inq	[24..31]	Buffer Size (Read Only) This field indicates the maximum size of receive/transmit data buffer. If this value=1, Buffer_Status_Control, SIO_Data_Register Char1-3 should be ignored
004h	Serial_Control_Reg	RE	[0]	Receive enable Read : Current status Write : 0 : Disable 1: Enable
		TE	[1]	Transmit enable Read : Current status Write : 0 : Disable 1: Enable
		-	[2..7]	Reserved
	Serial_Status_Reg	TDRD	[8]	Transmit data buffer ready Read only 0 : Not ready 1: Ready
		-	[9]	Reserved
		RDRD	[10]	Receive data buffer ready Read only 0 : Not ready 1: Ready
		-	[11]	Reserved
		ORER	[12]	Receive buffer over run error Read : Current status

				Write : 0: Clear flag 1: Ignored
		FER	[13]	Receive data framing error Read : Current status Write : 0: Clear flag 1: Ignored
		PER	[14]	Receive data parity error Read : Current status Write : 0: Clear flag 1: Ignored
		-	[15]	Reserved
008h	Receive_Buffer_Status_Control	RBUF_ST	[0..8]	SIO receive buffer status Read : Valid data size of current receive buffer Write : Ignored
		RBUF_CNT	[8..15]	SIO receive buffer control Read : Remain data size for read Write : Set input data size
		-	[16..31]	Reserved
00Ch	Transmit_Buffer_Status_Control	TBUF_ST	[0..7]	SIO ouput buffer status Read : Available data space of transmit buffer Write : Ignored
		TBUF_CNT	[8..15]	SIO output buffer control Read : Written data size to buffer Write : Set output data size for transmit
		-	[16..31]	Reserved
010h .. 0FFh				Reserved
100h	SIO_Data_Register	Char_0	[0..7]	Chracter_0 Read : Read character from receive buffer Padding data, if data is not available Write : Character to transmit buffer padding data if data is invalid
		Char_1	[8..15]	Chracter_1 Read : Read character from receive buffer +1 Padding data, if data is not available Write : Character to transmit buffer +1 padding data if data is invalid
		Char_2	[8..15]	Chracter_2 Read : Read character from receive buffer +2 Padding data, if data is not available Write : Character to transmit buffer +2 padding data if data is invalid
		Char_3	[16..31]	Chracter_3 Read : Read character from receive buffer +3 Padding data, if data is not available Write : Character to transmit buffer +3 padding data if data is invalid
104h .. 1FFh	SIO_Data_Register_Alias		[0..31]	Alias SIO_Data_Register area for block transfer

4.9.3. SIO (RS232) special Commands

SIO(RS232) special commands are non IIDC compliant and are specific mode for the Fire- cameras.

0xF2F10018	**Auto-Sync Mode control register** Bit 31 : auto sync enable Bit 30 : SIO enable mode (**0 : custom mode**, 1 : IIDC v1.31) Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)	Read/Write

Before using these commands serial communication parameters must be set at **Serial_Mode_Reg (F2F22000h)**

Baud Rate	Stop Bit	Parity	Flow Control
57600 bps(default)	1 bit	None	Non

- **Command format: [STX] [Command] [Data] [ETX]**

  [STX] : Command start character : 'S'

  Command] : Command length is 2byte. See next page command table.

  [Data] : Data length is varied with each command. Data format is hexadecimal: '0'~'9', 'A'~'F'.

  [ETX] : Command end character : 'Z'

- **Return value**

  'G' : Command complete acknowledge.

  "Gdd..d" : "dd..d" is return data and hexadecimal character.

  'U' : Undefined command.

- Valid Character: '0'~'9', 'A'~'F', 'S','Z' Invalid character is received is discarded.

- **Example: Gain setting command with 0x200 value**

  All of "SA0200Z", "S A0 200 Z", "SA0 200Z", "S A0200 Z", and "SKA0V200Z" are parsed to "SA0200Z".

- **SIO (RS232) Commands**

STX	Command	Data Length	ETX	Return Value	Function
S	A0	3Bytes	Z	G	**Gain control** (0x000 ~ 0x30F(BW Model) or 2D3(Color Model)) (see gain mapping graph) Ex) SA0200Z : Gain index value 512 (18dB)
S	A1	3Bytes	Z	G	**Shutter speed control** (0x001 ~ 0xCFB) (see shutter speed table)
S	A2	1Bytes	Z	G	**Set/Clear auto shutter speed and auto gain** Bit 0 : Auto gain Bit 1 : Auto shutter speed Ex) SA21Z : set auto gain and clear auto shutter speed SA23Z : set auto gain and auto shutter speed SA20Z : clear auto gain and auto shutter speed
S	A3	2Bytes	Z	G	**Auto exposure control** (0x00~0x64)
S	A4	1Bytes	Z	G	**Gamma control** (0x0~0x19) (see gamma table)
S	A5	3Bytes	Z	G	**Brightness control** (0x000~0x800)
S	A6	3Bytes	Z	G	**Sharpness control** (0x000~0x3F8)
S	A7	1Bytes	Z	G	**ISO control** 1: ISO enable, 0 : disable
S	A8	1Bytes	Z	G	**Trigger control** 1: trigger enable, 0 : trigger disable
S	AF	0Bytes	Z	'G'+18 Byte	**Read feature control value** Return value order 'G'[Gain] [Shutter] [Set/Clear auto gain and shutter] [Auto Exposure] [Gamma] [Brightness] [Sharpness] [ISO] [Trigger] Ex) At Command SAFZ, if return value is G001200132F20020101, Gain : 0x001 Shutter speed : 0x200 Set auto gain/Clear auto shutter speed : 0x1 Auto exposure : 0x32 Gamma : 0xF Brightness : 0x200 Sharpness : 0x201 ISO : 0x0 Trigger : 0x1
S	B0	16Bytes	Z	G	**RS232 synchronization** : RS232 buffer cleared in camera.
S	B1	8Bytes	Z	G	**Write access of 1394 address** Format : SB1 [address(8 byte)] [data(8byte)] Z Ex) SB1F2F1010012345678Z : write 0x12345678 data at 0xF2F10100 address
S	B2	0Bytes	Z	'G'+8 Byte	**Read access of 1394 address** Format : SB2 [address(8byte)] Z Ex) If command is SB2F2F10100Z and return value is G12345678, Read value of address 0xF2F10100 is 0x12345678.
S	B3	3Bytes	Z	G	**Return to default feature value** Return control feature : gain, shutter speed, auto exposure, brightness, sharpness, gamma, auto shutter speed, auto gain
S	Undefined Command	Any Byte	Z	U	**Undefined command** Return Value is 'U' character.

4.10. Frame Save Function

The Fire-i camera series cameras can save frames in the memory. The user can instruct the camera to stop integrating when the maximum number of frames, that can be stored in the memory, has been reached.

The number of frames that can be saved in memory depends on resolution, mode and it is different for each model. See the tables below for more details.

Fire-i 501/511/601

of maximum save frames : address 0xF2F10128, bit 16 ~ bit 23 read value		
Resolution	Mode 800	Mode 1600
320 x 240	31 frames	31 frames
640 x 480	15 frames	7 frames
800 x 600	15 frames	7 frames
1024 x 768	7 frames	3 frames
1280 x 960	3 frames	1 frames
1600 x 1200	3 frames	1frames

Fire-i 701/702/810

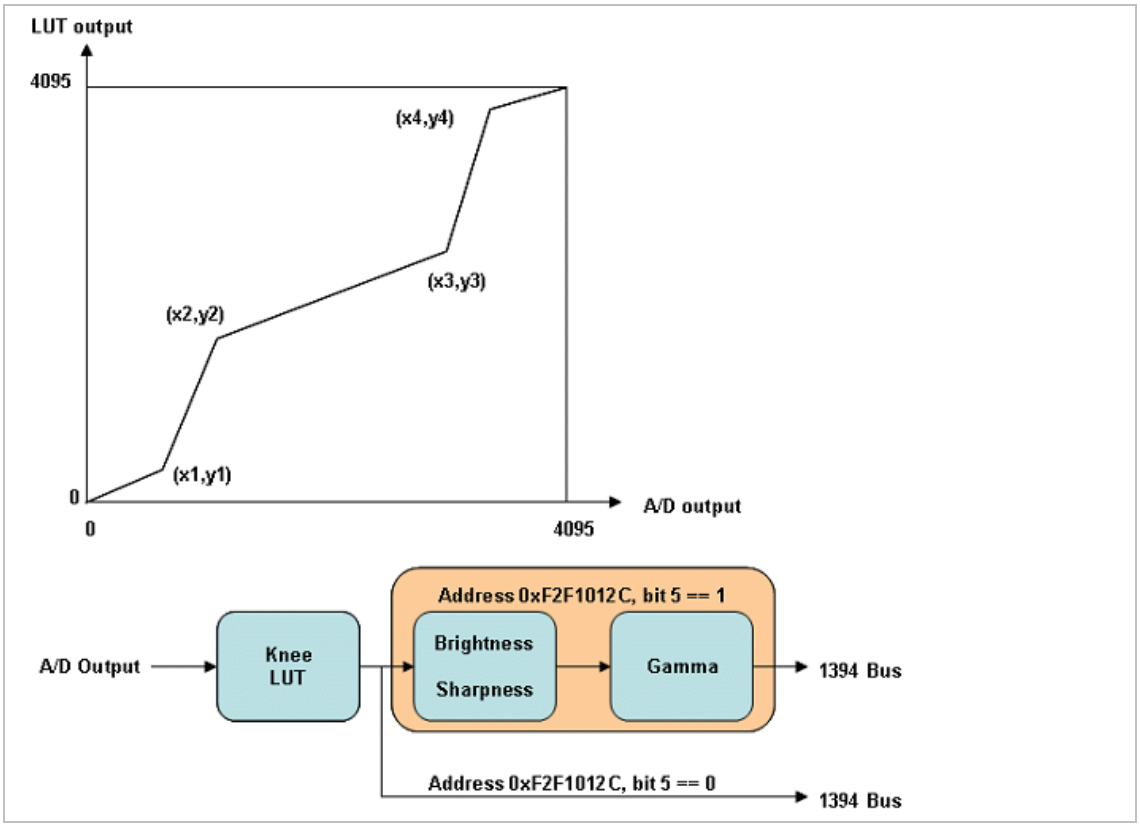
of maximum save frames : address 0xF2F10128, bit 16 ~ bit 23 read value		
Resolution	Mode 800	Mode 1600/Y422
320 x 240	127 frames	127 frames
640 x 480	63 frames	31 frames
800 x 600	63 frames	31 frames
1024 x 768	31 frames	15 frames
1280 x 960	15 frames	7 frames
1600 x 1200	15 frames	7 frames

4.11. LUT (Lookup table)

The Fire-i industrial cameras support a LUT (2008 production models or newer), which is providing users with an image with the user's defined dynamic range. Through the LUT, users can process the images from saturation to dark. The LUT can be used optionally with Brightness, Sharpness and Gamma. However, the applied sequence is that the LUT is applied prior to features like Brightness, Sharpness and Gamma.

4.11.1. 4 step knee lookup table

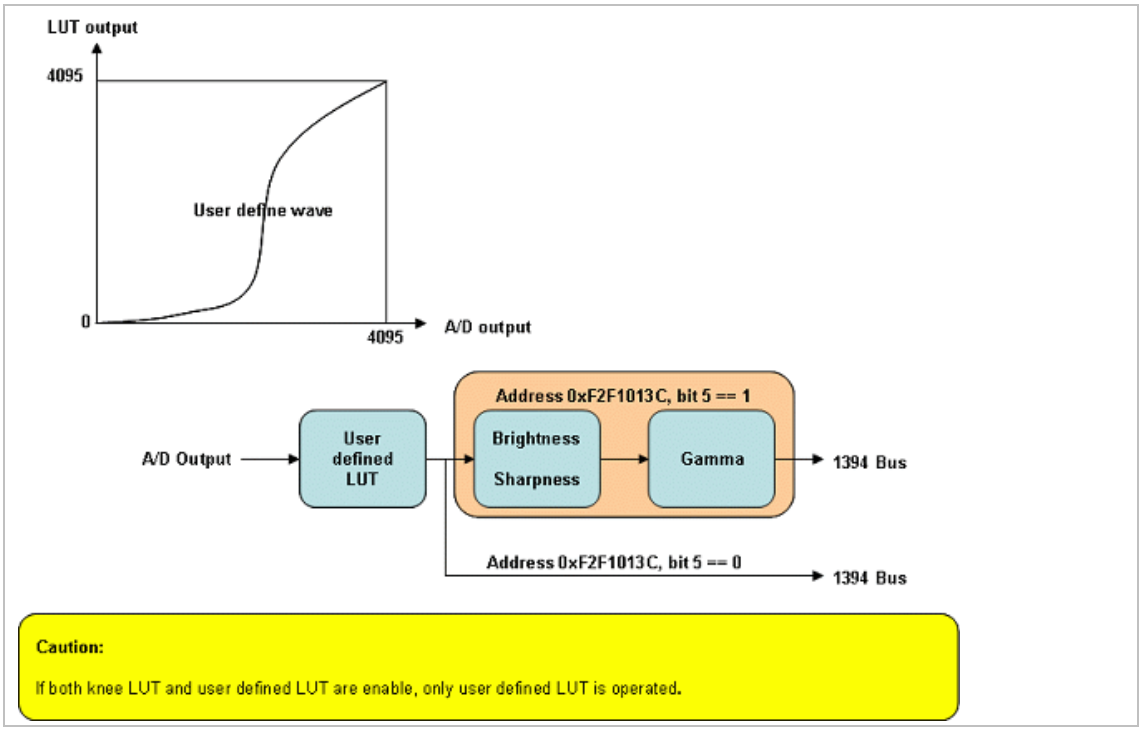
The user can set the 4 points for the images, called the knee, and apply them to LUT.



4.11.2. User defined lookup table

The user can set defined points (data file) for the images and apply them to the LUT. User's defined LUT running procedure is as follows. LUT index is N (o~15). The total index number of user's defined LUT is 16, but only one user defined LUT is used at a time.

Priority: User's defined LUT > 4 point LUT > Features (Brightness, Sharpness, Gamma)



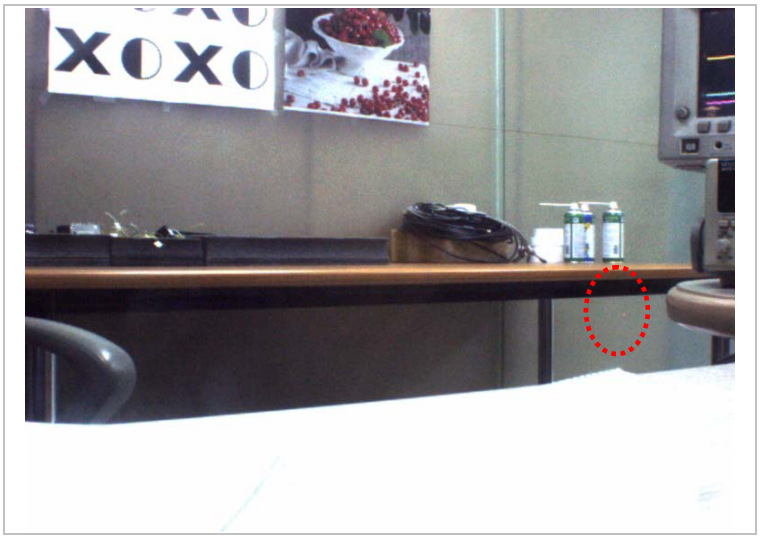
The user defined LUT save procedure is:

1. Check the save ready bit (bit1) status of the LUT save control register (0xF2F10140). If bit 1 is 0, wait.
2. Write 1 at the LUT buffer address init bit (bit7) of the LUT save control register (0xF2F10140) : 0xF2F10140 (<= 0x01000000).
3. Then write 4096 LUT data at the LUT data register (0xF2F10144).
4. Finally, write save command (bit0), LUT index (N: bit8 ~ bit11) at the LUT save control register: (0xF2F10140) : 0xF2F10140 (<= 0x80N00000).

4.12. One Pixel 'Snow Noise' removal

With this function, it is possible to average the value of snow noise pixel by using the neighboring pixels values. The formula used is: If ((Pi-Pi-1) > Threshold*16) and ((Pi-Pi+1) > (Threshold*16)), Pi is bad pixel. The purpose of the function is to increase the average pixels values for the whole image and be automatically displayed and the images can be compensated by over up to 50%. The register address and values for this function are:

Address	Description (bit 0: msb)	Read/Write
0xF2F20150	**One Pixel Snow Noise Remove** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 5 : reserved Bit 6 : on/off Bit 7~Bit23 : reserved Bit 24~Bit31 : Threshold Value (T) : If Pixel difference value > Threshold Value, then replace near pixel average Value	Write only



Before Snow noise image

After Snow noise removal

4.13. PIO Control Register

Short for Programmed Input/Output, PIO provides a set of IO ports which can be configured by the defined address. The PIO control register by 1394 address, for strobe and trigger signal, is as follows.

Address	Description (bit 0: msb)	Read/Write
0xF2F21000	PIO output register Bit 30 : Strobe GPIO output	Write only
0xF2F21004	PIO input register Bit 31 : trigger GPIO input	Read only
0xF2F21008	PIO GPIO enable register. Bit 30 : Strobe pin GPIO selector (1: GPIO, 0: strobe)	Read/Write

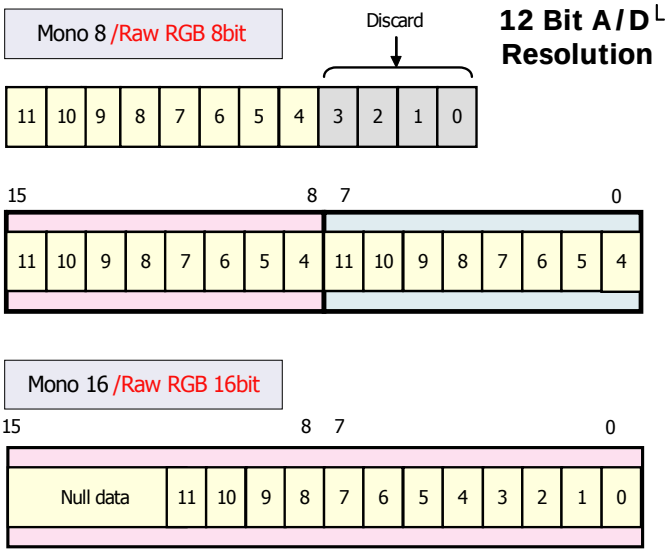
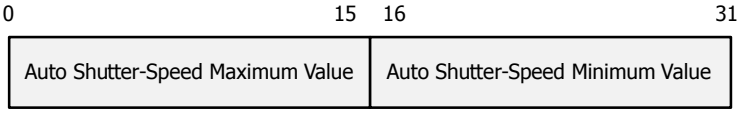
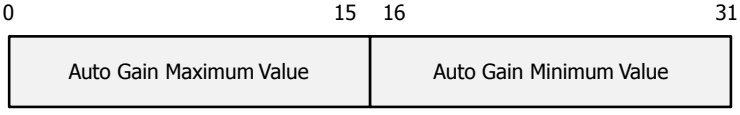
5. User Defined (custom) FireWire Registers

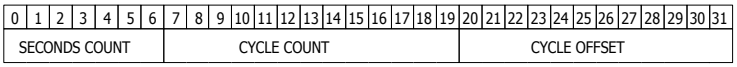
User defined registers are features undefined in the IIDC specification which Fire-i cameras are capable of.

User can utilize extended features of these specific firewire registers for application.

Note that for users who had previous versions of the cameras, several User Defined Registers have been incorporated in the IIDC V1.31 specification.

5.1. User Defined FireWire Address

Address	Description(bit : msb*)	Read/Write
0xF2F10000	**A/D bit resolution** Bit 28~Bit31 : A/D bit resolution Please refer to IIDC v1.31 data depth register (address: 0xF0F00630) 	Read only
0xF2F10004	**Auto shutter-speed maximum/minimum value register**.(32bit) At auto shutter mode, shutter speed value is checked between auto shutter-speed maximum value and minimum value 	Read/Write
0xF2F10008	**Auto gain maximum/minimum value register**.*(32bit) At auto gain mode, gain value is checked between auto gain maximum value and minimum value. 	Read/Write

<table>
<tr><td>0xF2F10018</td><td>Mode control register
Bit 31 : auto sync enable
Bit 30 : SIO enable mode (0 : custom mode, 1 : IIDC v1.31)
Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)</td><td>Read/Write</td></tr>
<tr><td>0xF2F1001C</td><td>1394 time stamp register(msb:bit0)
 

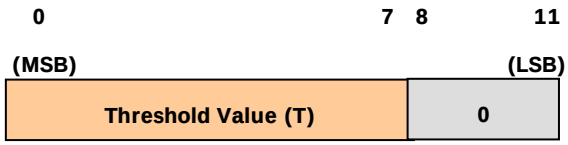
<table>
<tr><th>Bit Number</th><th>Bit Name</th><th>Function</th><th>DIR</th><th>Description</th></tr>
<tr><td>0 - 6</td><td>SECONDS COUNT</td><td>Seconds Count</td><td>R/W</td><td>1 Hz cycle timer counter</td></tr>
<tr><td>7 - 19</td><td>CYCLE COUNT</td><td>Cycle Count</td><td>R/W</td><td>8,000 Hz cycle timer counter</td></tr>
<tr><td>20 - 31</td><td>CYCLE OFFSET</td><td>Cycle Offset</td><td>R/W</td><td>24.576 MHz cycle timer counter</td></tr>
</table>
We recommend using native CYCLE_TIME register in Chap. 5.7.</td><td>Read only</td></tr>
<tr><td>0xF2F10100</td><td>Power on reset condition control register
Not Recommended
Please refer to IIDC v1.31 memory save/load channel.</td><td>Read/Write
(Self
Cleared)</td></tr>
<tr><td>0xF2F10104</td><td>Trigger control register
Not Recommended
Please refer to IIDC v1.31 trigger control register (address: 0xF0F00830)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10108</td><td>Software trigger
Not Recommended
Please refer to IIDC v1.31 software trigger register (address: 0xF0F0062C)</td><td>Read only</td></tr>
<tr><td>0xF2F1010C</td><td>Strobe control register. Only supports active high polarity.
Not Recommended Please refer to IIDC v1.31strobe control register (address: 0xF0F0048C -> 0xF2F23200)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10110</td><td>Trigger noise filter register (External trigger only)
Bit 22~Bit 31 : trigger masking range (M, unit : usec, range:0~ 999)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10114</td><td>Multi-cut exposure & interval time control (for Mode 14)
Bit 16 ~ 31 : exposure time (E)
Bit 0 ~ 15 : exposure time interval (P)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10184</td><td>Local ISO_EN control register for one-shot/multi-shot
Bit 31 : iso_enable (1: enable. 0: disable)</td><td></td></tr>
<tr><td>0xF2F1011C</td><td>Power on default memory channel
Bit 0 ~ Bit 3 : power on initial memory channel</td><td>Read/Write</td></tr>
<tr><td>0xF2F10200</td><td>Camera version register
Bit 16~Bit 31 : camera version
(ex: If reading value: 0x00003000, camera version is 3.000)</td><td>Read only</td></tr>
<tr><td>0xF2F10120</td><td>Bright Level for Iris Control Application
Bit 24 ~ Bit 31 : Bright Level for Image Capture</td><td>Read only</td></tr>
<tr><td>0xF2F10124</td><td>Test Pattern
Bit 0 : Vertical Grey Bar
Bit 1: Bias Grey Bar</td><td>Read/Write</td></tr>
<tr><td>0xF2F10158</td><td>Trigger mode 12/13 Gain/Shutter Control register
Bit 0 : Presence inquiry (read only)
Bit 5 : Setting complete (self cleared)
Bit 6 : Gain/Shutter table setting enable for trigger mode 12/13</td><td>Read/Write</td></tr>
</table>

	(1: 0xF2F1015C command enable, 0: no operation) Bit 8 : Gain/Shutter table access ready (read only: 1: ready, 0: not ready) Bit 10 : Gain/Shutter table save command (self cleared) Bit 11 : Gain/Shutter table load command (self cleared) Bit12 ~ Bit15 : Gain/Shutter table save/load index Bit 24 ~ Bit 31: Gain/Shutter table frame read start address	
0xF2F1015C	**Trigger mode 12/13 Gain/Shutter value register** Bit 0 ~7: Gain/Shutter index table address Bit 8 : Gain/Shutter increment (1: increment, 0: next frame have the same gain/shutter value Bit 9 ~ 19 : Gain value Bit 20 ~ Bit31 : Shutter value At read operation, read address is Trigger mode 12/13 Gain/Shutter Control register bit 24~ bit 31, and after read, Trigger mode 12/13 Gain/Shutter Control register bit 24~ bit 31 is automatically increment.	Read/Write

*msb: most significant bit

Address	Description (bit 0 : MSB)	Read/Write
0xF2F10128	**Defer Image control (Frame save)** Bit 0 : presence inquiry (read only) Bit 6 : defer image On/Off control (1: image hold mode, 0 : normal real time mode) Bit 7 : send image command: If bit 6 is on status, this bit is send image command from camera to PC. Bit 16 ~ Bit 23: Queue size inquiry : Must check whenever format or mode is changed (read only) Bit 24 ~ Bit 31: At read operation, this value is the number of images remaining in queue. At write operation, this value is the number of sending images by bit 7 send image command	Read/Write
0xF2F1012C	**4 step knee LUT run control register** LUT knee 1st point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit4 : reserved Bit 5 : enable brightness, sharpness, gamma feature with knee function Bit 6 : On/Off Bit 7 : reserved Bit 8~Bit 19 : X coordination of 1st knee point Bit 20~Bit31 : Y coordination of 1st knee point	Read only
0xF2F10130	LUT knee 2nd point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 2nd knee point Bit 20~Bit31 : Y coordination of 2nd knee point	Read/Write
0xF2F10134	LUT knee 3rd point register Bit 0 : presence inquiry (read only)	Read/Write

	Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 3rd knee point Bit 20~Bit31 : Y coordination of 3rd knee point	
0xF2F10138	LUT knee 4th point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 4th knee point Bit 20~Bit31 : Y coordination of 4th knee point	Read/Write
0xF2F1013C	**User defined LUT run control register** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 4 : reserved Bit 5 : enable brightness, sharpness, gamma feature with user defined LUT function Bit 6 : On/Off Bit 7 ~ Bit 11 : reserved Bit 12 ~ Bit 15 : run LUT index Bit 16 ~ Bit 31 : reserved	Read/Write
0xF2F10140	LUT save control register Bit 0 : save command Bit 1 : save ready status(read only) Bit 2 ~ Bit 6 : reserved Bit 7 : set LUT write buffer address to 0 Bit 8 ~ Bit 11 : save LUT index Bit 12 ~ Bit 31 : reserved	Read/Write
0xF2F10144	LUT data register (block write command) Save the first data at low word, then second data at high word Bit 0 ~ Bit 3 : reserved Bit 4 ~ Bit 15 : the second data Bit 16 ~ Bit 19 : reserved Bit 20 ~ Bit 31 : the first data	Write Only
0xF2F10160	**User defined AE X-axis value** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit4 : reserved Bit 5 : Make Command Bit 6 : On/Off (1: current setting value, 0: current image size) Bit 7 : reserved Bit 8 ~ Bit 19 : DAC or AE X-axis start position at current display image (AE_SX) Bit 20 ~ Bit 31 : DAC or AE X-axis width at current display image (AE_WX >= 4)	Read/Write
0xF2F10164	**User defined AE Y-axis value** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 4 : reserved Bit 5 : Make Command Bit 6 : On/Off (1: current setting value, 0: current image size) Bit 7 : reserved Bit 8 ~ Bit 19 : DAC or AE Y-axis start position at current display image	Read/Write

	(AE_SY) Bit 20 ~ Bit 31 : DAC or AE Y-axis width at current display image (AE_WY >= 4)	
0xF2F10150	**Snow noise remove threshold register** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 5 : reserved Bit 6 : on/off Bit 7 : grid noise filter enable mode f or mono800 at color camera (0:disable, 1: enable) Bit 8~Bit23 : reserved Bit 24~Bit31 : Threshold Value (T) : If Pixel difference value > Threshold Value, the pixel is replaced with near pixel average value  **Pixel compared threshold value bit map**	Read/Write
0xF2F10168	**Another sharpness** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit5 : reserved Bit 6 : On/Off Bit 7 : reserved Bit 8 ~ Bit 23 : reserved Bit 24 ~ Bit 31 : sharpness value (10: normal, range 5 ~ 20)	Read/Write

6. Video Formats and Modes

IIDC specification defines several video formats. An overview of those formats is:

- Format 0: Video formats up to VGA (640 x 480) resolution.
- Format 1: Video formats for SVGA (800 x 600) and XGA (1024x768) resolution.
- Format 2: Video Formats for SXGA or higher resolutions (1280 x 960 and 1600 x 1200)
- Format 6: Still Images
- Format 7: Scalable images sized (User defined size and position)

Format 0 / Format 1 / Format 2

In these formats, the frame rates are pre-defined for each video mode as per the IIDC specification.

There are several defined modes for each format where a mode specifies the size and color information of the pixels. By reading the inquiry register of the camera, the user may determine which frame rates are supported by the camera. Please refer to the IIDC specification for the details.

Format 7

Format 0, 1, & 2 were defined at the early stage of the design and development of digital industrial cameras; where cameras supported these common VESA compliant resolutions. Because the user required a flexible and definable format; camera manufacturers utilized the user definable Format 7 to meet this demand. Format 7 is extremely flexible and allows the user to define the width, height, position and pixel format of the video data where separate sets of control registers exists for each Format 7 mode.

The cameras support Format 7 Mode 0, 1, 2 with the following base address:

Format 7 Mode 0 : F1F00000h Format 7 Mode 1 : F1F00100h Format 7 Mode 0 : F1F00200h

Offset	Name	Description
000h	MAX_IMAGE_SIZE_INQ	Maximum Horizontal / Vertical pixel number
004h	UNIT_SIZE_INQ	Horizontal and Vertical unit pixel number
008h	IMAGE_POSITION	Left / Top position of requested image region (pixel)
00Ch	IMAGE_SIZE	Width / Height of the requested image region (pixel)
010h	COLOR_CODING_ID	Color coding ID from COLOR_CODING_INQ register
014h	COLOR_CODEING_INQ	Inquiry register for color information setting
034h	PIXEL_NUMBER_INQ	Pixel number per frame
038h	TOTAL_BYTE_HI_INQ	Higher quadlet of total bytes of image data per frame
03Ch	TOTAL_BYTE_LO_INQ	Lower quadlet of total bytes of image data per frame
040h	PACKET_PARA_INQ	Unit (Minimum) bytes per packet Multiple by 4 Maximum bytes per packet Multiple by UnitBytePerPacket
044h	BYTE_PER_PACKET	Packet size, Recommended bytes per packet. If this value is zero, shall ignore this field.

Please refer to the IIDC specification for further details.

NOTE: In Format 7 Mode, frames rates may vary which may depend on Size, Color, bytes per packet, shutter and system performance.

According to different models of the Fire-i camera series supported video format, modes and frame rate are different.

Notes: Color Models outputs Raw Bayer Pattern which is converted by software.

: Unsupported Mode as per IIDC 1.31 Specification

6.1. Fire-i 810

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV422			O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8			O	O	O	
	6	640 x 480	Mono 16			O	O	O	
1	0	800 x 600	YUV 422			O	O		
	1	800 x 600	RGB 8						
	2	800 x 600	Mono 8			O	O		
	3	1024 x 768	YUV 422						
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8			O	O	O	O
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
2	0	1280 x 960	YUV 422				O	O	O
	1	1280 x 960	RGB 8						
	2	1280 x 960	Mono 8			O	O	O	O
	3	1600 x 1200	YUV 422				O	O	O
	4	1600 x 1200	RGB 8						
	5	1600 x 1200	Mono 8			O	O	O	O
	6	1280 x 960	Mono 16			O	O	O	O
	7	1600 x 1200	Mono 16				O	O	O
7	0	1600 x 1200	16 fps						
	1	800 x 600	29 fps 2x2 binning (H&V Binning)						
	2	1600 x 600	29 fps 1x2 binning (V Binning)						

6.2. Fire-i 701/702

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV422			O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8			O	O	O	
	6	640 x 480	Mono 16			O	O	O	
1	0	800 x 600	YUV 422			O	O	O	
	1	800 x 600	RGB 8						
	2	800 x 600	Mono 8			O	O		
	3	1024 x 768	YUV 422			O	O	O	O
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8			O	O	O	O
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
2	0	1280 x 960	YUV 422				O	O	O
	1	1280 x 960	RGB 8						
	2	1280 x 960	Mono 8			O	O	O	O
	3	1600 x 1200	YUV 422						
	4	1600 x 1200	RGB 8						
	5	1600 x 1200	Mono 8						
	6	1280 x 960	Mono 16				O	O	O
	7	1600 x 1200	Mono 16						
7		1388 x 1036	20 fps / 35fps (1388 x 520 Format 7, Mode 0) for Color Models						
	0	1388 x 1040	20 fps / 35fps (1392 x 520 Format 7, Mode 0) for B&W Models						
		1388 x 1036	20 fps / 35fps (1388 x 520 Format 7, Mode 0) for Color Models						
	1	688 x 516	37 fps 2x2 binning (H&V Binning) for B&W Models Only						
	2	1384 x 516	37 fps 1x2 binning (V Binning) for B&W Models Only						

6.3. Fire-i 601

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV422		O	O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8		O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
1	0	800 x 600	YUV 422		O	O	O	O	
	1	800 x 600	RGB 8						
	2	800 x 600	Mono 8		O	O	O		
	3	1024 x 768	YUV 422			O	O	O	O
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8		O	O	O	O	O
	6	800 x 600	Mono 16		O	O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
7	0	1024 x 768	36 fps / 63 fps (1024 x 384, Format 7 Mode 0)						
	1	512 x 384	69 fps 2x2 binning (H&V Binning) for B&W Models Only						
	2	1024 x 384	69 fps 1x2 binning (V Binning) for B&W Models Only						

6.4. Fire-i 501/511

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV422		O	O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8	O	O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
7	0	640 x 480	86 fps / 154 fps (640 x 240, Format 7 Mode 0)						
	1	320 x 240	157 fps 2x2 binning (H&V Binning) for B&W Models Only						
	2	640 x 240	157 fps 1x2 binning (V Binning) for B&W Models Only						

7. Trouble Shooting

FireWire based camera are operated in connection with system where user may encounter problems as they operate. These problems may orient either from the camera side or the system side that the camera is being used. We recommend reading the manual carefully beginning from the installation to features in concern. Also some system may not have enough power to operate these cameras especially for high resolution and frame rate we recommend the system should be Pentium 4 or higher with 512 MB of System memory and Graphic Accelerator with 32 MB or more of video memory. When using Windows, due to high graphic requirements and DirectX support, we recommend using at least Nvidia or ATI graphics controllers.

7.1. Hardware Related Issues

Camera is not recognized in the device manager

- Please check whether the LED in the back of the camera is ON. If LED is tuned OFF, please check camera connection. Please check the cable connection on both the camera and the PC. The LED status, when plugging in the camera is supposed to be normal when the LED light changes from an Orange light to a Red light.
- If you haven't installed the camera driver yet, please refer to the software installation and install the drivers and software provided.
- Please reconnect the camera by plugging out the FireWire cable and plugging in the cable connected on the camera.

LED is OFF while power is provided either by FireWire or external power.

- Please check the supplied voltage and ensure the supplied power is compliant to the operation manual.
- Please check the firewire card and cable(s).

Camera Power

As described in this manual the power of the camera is provided either by the FireWire cable or the external power through 12 Pin Trigger Port. Please be careful when using external power input through the trigger port and refrain from using power over +30V DC. In normal condition we recommend using +12V DC. Also please check the operation manual for the power connection pin assign for external power input to avoid damaging the camera.

No Image or Black Image Displayed

Check the "Status LED" if it appears Green. If Not, camera is not Isochronous enabled which means not transmitting any image and is in an idle stage.

Check whether the lens is properly mounted and open the iris it to the maximum level.

Check feature values such as shutter speed, gain and exposure. Also check whether the camera is in trigger mode.

8. Technical Support

We ensure the conformity of our product to be reliable and free from defects during manufacturing by testing all the cameras before release. However unexpected problems and technical issues may come up due to the complexity of the product. In case you require technical support contact the agent near you or you may contact us directly with the following information.

Web information, specifications, FAQs: http://www.unibrain.com/

Technical support email: support@unibrain.com

Sales inquiries: sales@unibrain.com

Telephone Numbers:

Europe/Asia: +30210-6640600

USA/Canada/South America: +1-925-866-3000

In case of RMA, you must first contact us or your local reseller in order to obtain the RMA Number before sending the product to us. The returns contact email address is: rma@unibrain.com